ENGINEERING NEWS.

Tribune Building, New York City.

GEO. H. FROST, PROPRIETOR.

SATURDAY, SEPT. 3, 1881.

WE received the following note from Prof. P. H. Philbrick, dated Iowa City, Aug. 23, 1881: "I hope Mr. E. J. Ward will be able to continue his articles on 'Wind Pressure.' The matter has been much neglected and slighted in the past."

TO THOSE INTERESTED IN WATER-WORKS.

Owing to the author's absence from this city on professional duty the manuscript of "The History and Statistics of American Water-Works" has not reached us in time for this week's issue. We take advantage of the space thus afforded us to call the attention of those officers of water-works who have not yet responded to the requests for information regarding their works to the scope and character of Mr. Croes' book, and we desire to again urge them to furnish the memoranda required to make this history complete. It is intended that it shall be complete, and the information will be obtained to make it so, in one way or another. The simplest and easiest way will be for those who possess all the data to contribute them as early as convenient.

We are fully aware of the fact that superintendents of water-works are overwhelmed with circulars from all quarters asking for elaborate information on every conceivable subject connected with the construction and management of works of water supply. If they reply, their answers are either buried in the files of some little company's office, or printed in a report of some obscure town which reaches only a small proportion of those who are interested in the matters treated. The work which we are now publishing will, to a very large extent, obviate the necessity for the asking of such questions. It will be a practical manual of water-works construction and management, treating not of theoretical questions, but giving the results of actual experience, without attempting to excuse blunders, explain away failures, extol successes, or expiate on the merits of any particular system of construction, supply or management.

The idea of this book grew out of the effort to procure a general description of the works of water supply in America for the Centennial exposition in 1876. The American Society of Civil Engineers exhibited then a very creditable collection of plans, models and statistics, gathered for the purpose by Mr. Croes, who had charge of that branch of the work of the society's Centennial Commission. The catalogue of that exhibit contained the first list of American towns having water-works ever published. It was necessarily incomplete, owing to the short time allowed for its compilation, but even then comprised the names of all the works of any importance, and seventy-five per cent. of all which were then in existence.

In the following year, Mr. Edward Prince, C. E., of Quincy, Ill., published a list of water-works which has been enlarged from time to time through his earnest and persistent efforts to procure information. He has kindly placed at Mr. Croes' disposal the catalogue of reports and documents obtained by him, and such brief abstracts of them as had been prepared by him.

The publication of Mr. Croes' book began in the issue of ENGINEERING NEWS for March 5, 1881. Up to this time, statistical and historical sketches of eighty-one water-works have appeared, as follows, the towns being at first arranged according to their population by the last census, an arrangement afterwards abandoned on account of the difficulty of procuring the very latest reports in time:

	Town.	Population.	Page.	Date.
I.	New York, N. Y.	1,206,500	91	March 5
II.	Philadelphia, Pa	846,984	102	12
III.	Brooklyn, N. Y.	566,680	114	19
IV.	Chicago, Ill	503,304	122	26
V.	Boston, Mass.	362,535	131	April 2
VI.	St. Louis, Mo.	350,522	142	9
VII.	Baltimore, Md.	332,190	151	16
VIII.	Cincinnati, O.	255,708	153	16
IX.	San Francisco, Cal.	233,956	163	23
X.	New Orleans, La.	216,140	163	23
XI.	Cleveland, O.	160,142	163	23
XII.	Buffalo, N. Y.	155,137	173	30
XIII.	Washington, D. C.	147,307	174	30
XIV.	Newark, N. J.	133,400	183	May 7
XV.	Louisville, Ky.	123,645	183	7
XVI.	Detroit, Mich.	116,342	193	14
XVII.	Providence, R. I.	104,850	195	14
XVIII.	Montreal, Can.	145,000	202	21
XIX.	Milwaukee, Wis.	115,578	203	21
XX.	Jersey City, N. J.	120,728	236	June 4
XXI.	Albany, N. Y.	90,903	226	4
XXII.	Indianapolis, Ind.	75,074	227	4
XXIII.	Rochester, N. Y.	89,363	233	11
XXIV.	Lowell, Mass.	59,485	234	11
XXV.	Pittsburgh, Pa.	156,381	234	11
XXVI.	Allegheny, Pa.	78,681	243	18
XXVII.	Kansas City, Mo.	55,813	263	July 2
XXVIII.	Cambridge, Mass.	52,740	264	2
XXIX.	Fall River, Mass.	49,006	264	2
XXX.	Richmond, Va.	63,803	264	2
XXXI.	Toronto, Can.	85,000	271	9
XXXII.	Worcester, Mass	58,295	272	9
XXXIII.	Troy, N. Y.	56,747	283	16
XXXIV.	Ottawa, Can.	22,000	285	16
XXXV.	Lawrence, Mass.	39,178	285	16
XXXVI.	Manchester, N. H.	32,630	287	16
XXXVII.	Bay City, Mich.	20,653	287	16
XXXVIII.	Hartford, Conn.	42,553	293	23
XXXIX.	Lynn, Mass.	38,284	293	23
XL.	Grand Rapids, Mich	32,015	294	23
XLI.	Holyoke, Mass.	21,851	294	23
XLII.	Hudson, N. Y.	8,009	294	23
XLIII.	Springfield, Mass.	33,340	302	30
XLIV.	Salem, Mass	27,598	303	30
XLV.	Newport, Ky.	20,433	304	30
XLVI.	Norwich, Conn	21,141	304	30
XLVII.	Williamsport, Pa.	18,934	304	30
XLVIII.	Dayton, O.	38,677	304	30
XLIX.	Toledo, O.	50,143	305	30
	L. Sandusky, O.	15,838	305	30
LI.	Charleston, S. C.	49,999	311	Aug. 6
LII.	Terre Haute, Ind.	26,040	311	6
LIII.	Taunton, Mass.	21,213	312	6
LIV.	Newton, Mass.	16,995	312	6
LV.	Alexandria, Va.	13,658	312	6
LVI.	Kalamazoo, Mich.	11,937	312	6
LVII.	New London, Conn.	10,529	312	6
LVIII.	Poughkeepsie, N. Y.	20,207	313	6
LIX.	New Bedford, Mass.	20,875	327	13
LX.	Lambertville, N. J	4,300	328	13
LXI.	London, Can.	21,000	328	13
LXII.	New Albany, Ind.	16,422	328	13
LXIII.	Montgomery, Ala.	16,714	329	13
LXIV.	Northampton, Mass.	12,172	329	13
LXV.	Columbus, O.	51,660	329	13
LXVI.	Mankato, Minn.	6,000	329	13
LXVII.	Waterbury, Conn.	20,269	332	20
LXVIII.	Newburgh, N. Y.	18,050	332	20
LXIX.	Corning, N. Y.	4,803	332	20
LXX.	Norfolk, Va.	21,966	333	20
LXXI.	Erie, Pa.	27,730	333	20
LXXII.	Marshalltown, Iowa.	6,000	333	20
LXXIII.	Binghamton, N Y.	17,315	333	20
LXXIV.	Paris, Ill.	4,350	333	20
LXXV.	Pawtucket, R. I.	19,030	333	20
LXXVI.	Peekskill, N. Y.	6,893	341	27
LXXVII.	Atlanta, Ga.	34,398	342	27
LXXVIII.	Burlington, Iowa.	19,450	342	27
LXXIX.	Altoona, Pa.	19,740	342	27
LXXX.	Johnstown, N. Y.	16,626	342	27
LXXXI.	Yonkers, N. Y.	18,892	342	27

While this list includes but a small portion of the whole number of water-works in the country, the descriptions of the works contain already a more valuable collection of facts relating to water-works construction and maintenance, the accidents and failures of ill-considered and carelessly constructed structures, the cost of construction and maintenance, and the revenue derived from water supply, than any other single publication ever issued. To make this record complete is the author's intention and our desire. A large amount of material is now on hand for this purpose. *We want everything*, and we therefore again ask every superintendent, engineer, manager and commissioner to send us reports, facts and figures.

The sketches, comprising the first part of the book, are arranged according to the following order, for each town: Location and topography of town, date of first settlement and of incorporation, date of construction of water-works and description of same, both old and new; sources of supply, filters and wells, pumping engines or reservoirs, supply mains or conduits, reservoirs, distribution, sizes and kind of pipes; number of hydrants, taps and meters, cost of construction and maintenance, and the revenue, both total to date and particularly for the year 1880; organization and officers of works, daily average consumption. Failures and accidents of all kinds are specially noted. Hereafter tabular statements of the chief points of interest will be given, including duty and cost of pumping engines.

Many officers of works have contributed descriptions of their works admirably fitted for insertion in the book, without material change, and the compiler's labors are, of course, greatly lessened by such kind assistance. The interest taken in the work is exhibited in the most gratifying manner by correspondents from all parts of the country, and the author and the publisher are alike encouraged to carry out the design to its full extent.

SUBTERRANEAN CONDUCTORS.

The problem of providing some effective plan for placing electric wire underground is, at the present time, attracting much attention. In all large cities the network formed by these wires interferes most materially with the efficient working of the fire departments, and as it is exposed to every atmospheric change it is damaged, and in its damage hurts the interests of the entire community.

The number of these wires is rapidly increasing, caused by the extension of the telegraph, telephone and electric lighting systems, and a device is imperatively demanded by which the present practice may be done away with.

We have received a pamphlet from Mr. Stephen Chester, C. E., which discusses the question: Are subterranean telegraph lines practical? After citing the various evils consequent to the system now in vogue, the author enumerates the principal objections alleged to exist against the use of subterranean conductors, by reputable experts, as follows:

"First.—All underground conductors are relatively very much more costly than are air lines.

"Second.—Breaks in wires or imperfections in insulation cannot be readily located, and the repairs of the same would be expensive and difficult.

"Third.—No material yet used for insulation of subterranean wires has been satisfactorily proved to be indestructible, nor do any of such materials when buried in the ground retain their integrity nearly so well as do submarine conductors.

"Fourth.—The obstacles impeding the efficient use of long, continuous conductors because of "*Induction*" and "*Retardation*," are vastly greater in buried wires than they are in aerial lines of corresponding length."

These allegations are met by the statement that the subterranean conductors, referred to as enormously costly, have consisted of copper wires, first covered with an expensive insulating substance such as vulcanized rubber, kerite or gutta-percha, and still further protected by being inclosed in metal tubes.

In all the many uses to which insulated wires have been applied, it has been requisite that the insulating covering should be impervious to water, flexible, and of such tenacity and durability as not to be liable to injury in the handling necessary to place them in position, nor to deterioration in conducting or insulating qualities by reason of exposure to heat or cold, air or water, etc.

Up to the present time all compositions uniting these qualifications have been expensive, and only readily applied to very flexible and therefore small wires. The wires used have been mostly of copper, as this metal possesses a conducting power much greater than iron for equal sizes.

As such insulated conductors are relatively much more expensive than those used on aerial lines, and possess but little relative tensile strength, and the insulating covering is not of a character that will stand rough handling or abrasion without injury, they have but seldom been placed under ground or water without being further protected by some other non-insulating but hard and tough covering. This adds greatly to the original cost. In order to

avoid this cost, in some measure, it has been the custom to inclose several insulated wires in cable form in one metal tube, which protects them from external injury. Mr. Chester states that from this fact arises, in a great measure, the second alleged objection, namely, the difficulty of exactly locating imperfections, and of repairing them. He also asks:

"Why do those who, from pecuniary or other interest therein most earnestly oppose the removal of poles from the streets, assume as a self-evident proposition that buried conductors *must* be covered with a *flexible* insulating substance, and be inclosed in a tube? Buried in the ground is the one condition in which a conductor is absolutely removed from all liability to flexion, torsion, abrasion, or longitudinal strain, and flexibility of conductor or insulation is of no possible importance."

It is stated that the subterranean conductor should possess the following qualities:

"First.—It must throughout its whole length be completely and entirely insulated; not only in the present, but free from all prospective defects in insulation. Therefore,

"Second.—The insulating material should of itself be practically indestructible and not subject to harmful changes in condition because of even extreme heat or cold.

"Third.—The insulating material should be entirely free from any element that might chemically affect the inclosed conductor.

"Fourth.—The arrangement of such conductors should be such that no derangement of the wires or insulation can be mechanically caused by the expansion or contraction of the wires.

"Fifth.—While strict compliance with the above conditions will render such conductors exempt from liability to derangement or deterioration from any ordinary cause of accident, the arrangement of parts should be such as to facilitate the free examination of each conductor separately, in order to locate any fault exactly, and its instant correction possible and easy.

"Lastly.—The cost of such subterranean fixed and indestructible conductors should not greatly exceed that of the present lines which disfigure our streets and threaten the safety of our persons and property."

As an effective method of constructing such conductors the author states that they need be merely naked wires, unprotected either by insulating coverings, or for protection against oxidation. They may be imbedded in parallel lines, in a cement formed of a siliceous base, such as sand saturated with a paraffine compound, which would insure perfect insulation, and protection against oxidation. A cement of such character would possess no oxidizing properties, would not unite with the metal wire, nor cling to it, and each straight length of wire would be free to move longitudinally within its surrounding matrix of cement, but would be securely prevented from any lateral movement, or approaching any other parallel adjacent wires.

Where a deviation from a straight line is required, the wires may be broken and expansion joints inserted, permitting free longitudional motion in each section without interrupting the metallic connection.

In places where separate groups of wires meet, on transverse routes, the ends may be brought to the surface in properly constructed boxes, in order to facilitate the "making up" of routes by joining the terminals. These also afford ready means of testing short sections of wire.

In replying to the third objection, the writer states that sand saturated with compound of paraffine forms a cement that is indestructible by any causes to which subterranean conductors could be possible exposed. He prepared in 1867 a small wooden trough, perhaps eight feet in length, with a cross-section of two square inches, in which he placed a number of wires imbedded in a cement of the character described. This was exposed for several years to the greatest heat of the summer sun and to the extreme frosts of winter and to water. Up to the present time the most severe tests failed to detect the slightest deterioration of either conductor or insulator.

We now come to the consideration of the most important objection—induction and retardation. The author admits, without entering the field of technical discussion, that conductors, "electrically occupied, exercise reciprocal influences upon each other when running in the same directions. The effect of such influences is to confuse and disturb the normal effect that should be produced through each conductor by its separate electric change." This influence is rendered greater or less by the following conditions:

"First.—It is greatly increased or decreased as the parallel conductors approach or are separated from each other.

"Second.—It is increased as the length of the parallel conductors is increased, or, as it may be better stated, these effects are proportionate to the 'resistance of the conductors.'

"Third.—It is apparent that the intensity of such effects must be more or less modified by the greater or less insulating properties of the medium separating them."

These phenomena manifest themselves when the conductors are not submerged in water nor buried in the earth; they are detected in aerial lines and in submarine cables. Although in aerial lines the wires are seldom less than twelve inches apart for any considerable distance, it is a well-known fact that many of those using telephone lines in this city are frequently annoyed by effects produced upon their wires by electric impulses communicated from other separate conductors running in their near vicinity.

The author does not claim that wires laid as above described in a perfectly insulating and indestructible cement would be absolutely free from the effects of induction and retardation, since they are in a greater or less degree to be detected in all parallel conductors at whatever distance from each other, and however well insulated; but the intensity of such effect diminishes very rapidly in proportion to the increased distance. It may, for the purpose of approximate computation, be assumed that all other conditions being the same, it is in inverse proportion to the square of the distance of the conductors from each other.

The author sums up this subject in the following conclusions:

"First.—It is not impossible to construct systems of underground conductors in such manner as to be available for every purpose to which electricity has been applied, as completely as are the suspended conductors which now disfigure our streets, and expose our persons and property to constant risk.

"Second.—Such conductors, subject to hardly any conceivable liability to derangement, are, nevertheless, more easily reached for examination and repair, and with less interruption and annoyance to passage than are pole lines.

"Third.—Such conductors would be practically indestructible.

"Fourth.—Costing less than pole lines, in their original construction, the cost of maintenance may be assumed as nothing."

THE ISTHMUS OF PANAMA.

There have been several reports lately of an unfavorable character, not only with regard to the sanitary condition at Panama, but also in relation to the progress of the works. We think it better to give here two versions; one coming from Mr. Huerne, who lately arrived at San Francisco from Panama, and who was interviewed by a reporter of the *Chronicle*; the other is a translation of the official bulletin of the Interoceanic Canal.

Mr. Huerne stated that the reports of great mortality and sickness among the engineers was false. They were, however, to be found along the entire length of the canal, and sometimes in the midst of thick forests and swamps. Mr. Huerne compared the engineers to a brave little army disseminated along the route, but this very scattering of the forces is not understood by laymen and railroad travelers. On the whole, Mr. Huerne thought that no great progress could have been made.

The last bulletin gives the work done during month of June. The planimetry and taking the level of the railway are terminated from Colon to beyond Pedro Miguel, on the Pacific Slope, and landmarks cut on the railroad bridges. The levels of the mountain region are almost finished, with the exception of those of some trochas between Obispo and Chagres. The summits of the neighboring mountains have been bared of wood, so as to facilitate the trigonometrical operations. Two brigades are superintending the dam and reservoir of the upper Chagres. Another brigade has been organized to follow out a variation of the trace of the canal across the mountainous regions between the Upper Obisbo and the Pedro Miguel. Another variation is also being followed out, for an outlet at the city of Panama, instead of at the mouth of the Rio Grande.

A fluviograph is to be placed on the Chagres at Gamboa, for the purpose of studying the rise of the river, and also on its affluents. The engineers at Colon have been studying the outlet of the canal, and the defensive works for the port. The hydrographic corps made forty-two excursions for sounding, studying the currents, etc. About 1,500 soundings were taken. It was found that the bottom of the bay of Colon is a vast deposit of mud, in some parts sand is mixed with it to a degree to make somewhat firm, and is greater toward the bank, which is formed of pure sand and shells. Borings have been made along the thicket of Culebra. One of these bores has a depth of 50.15 m. At 48.70 m. hard rock was found. Most of the borings show argillaceous formation.

The remaining details are unimportant, but would show that matters are being pushed forward as rapidly as possible—according to the statements of M. de Lesseps.

PERSONAL.

Mr. Geo. H. Frost, of this journal, returned to the city on Wednesday, the 31st ult.

Mr. Edward P. Adams, of Medford, Mass., has accepted a position on the Northern Pacific Railroad, with headquarters at Brainerd, Minn.

The office of Mr. M. J. Becker, Chief Engineer of the Pittsburgh, Cincinnati & St. Louis Railway, has been changed from Columbus, O., to Pittsburgh, Pa.

Mr. A. Bonzano, of the firm of Messrs. Clarke, Reeves & Co., with his family, sailed for Europe on the 17th ult., with the intention of being absent several months.

Edward Prince, C. E., of Quincy, Ill., who has been spending several months in Europe, returned on the 29th ult., and proceeded at once to Quincy. He has been very successful in collecting information on the subject of levees and dykes.

Mr. Frederic Graff, the well-known Hydraulic Engineer, and President of the Engineers' Club, of Philadelphia, and Mrs. Graff, are spending a month at Saratoga. They are at the United States Hotel, where Mrs. Graff has been quite ill for two weeks past, but is now able to be about as usual.

A. M. Wellington, engineer in charge of location and surveys of the National Mexican Railway Co., has been appointed Chief Engineer of the Vera Cruz-Jalapa-Pueblo Railway, a line projected and in part under construction. Mr. Wellington holds both appointments, with address, as heretofore, at City of Mexico.

We make the following extracts from a letter received by us from Mr. Thomas H. Loomis, written at the office of the Chief Engineer of the Sinaloa & Durango Railroad Company, at Culiacan, Mexico:

"We landed at Mazatlan safely on June 10, and shortly after at this place, on the line of our road.

Mr. North has not yet reached us, but is now looked for any day, when the work will be pushed to construction with all possible speed. We arrived just in time for the rainy season, and about one-half of our men have had a more or less severe touch of the fever. All the sick are now, however, recovering rapidly. The thermometer in our office has not yet been above 88°.

The following sad announcement we clip from the Bismarck, Dakota, *Tribune* of the 18th ult.: "Mrs. H. W. Parkhurst, wife of Resident Engineer Parkhurst of the Bismarck Bridge, died at her home at the upper landing at nine o'clock yesterday morning. Mrs. Parkhurst arrived in Bismarck to join her husband but a short time since, but her bright, cheerful disposition, lady-like manners and evidences of culture and refinement at once won to her side very many friends, who will as sincerely mourn her death as those to whom she is more nearly related, or those who have the good fortune to enjoy a more intimate acquaintance. The fatal illness was typhoid fever, and although the deceased has been ill some time, the physicians and friends did not anticipate the sad result. The home of Mrs. Parkhurst was in Rhode Island, and the bereaved husband, who has the sympathy of his acquaintances, will accompany the remains on the sad journey to that State to-day."

A NEW SYSTEM OF SEWERAGE.

The sewerage of Paris continues to attract the attention of French sanitary engineers, not to mention a few distinguished representatives of the profession from this side.

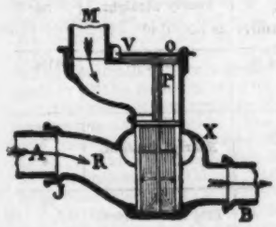


FIG. 1.—LONGITUDINAL SECTION.

FIG. 3.—TRANVERSE SECTION.

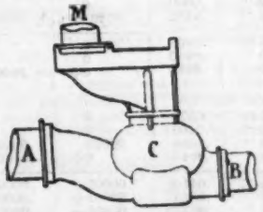


FIG. 4.—EXTERIOR VIEW.

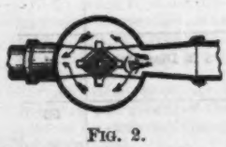
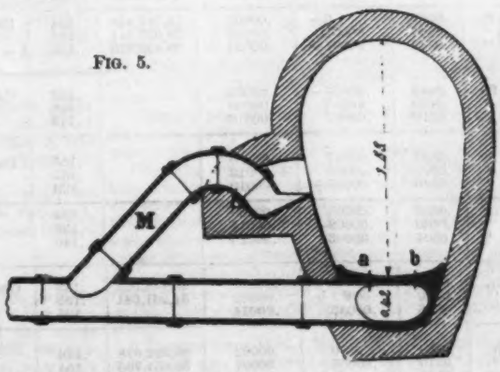


FIG. 2.
PLAN AT HEIGHT OF BASIN.

FIG. 5.



A NEW SYSTEM OF SEWERAGE.

The accompanying cuts show a system which has been proposed by M. Eugene Miotat, the present superintendent of the sanitary department. It consists of a diluting apparatus, so arranged as to send into a special drain, to be under the existing system, all the liquid residuum of slops, rain water, etc., and would thus be distinct from the street drainage proper.

The apparatus consists of a basin *C*, circular, and with convex sides attached to the upper part of a pipe, connecting at both ends with the existing canalization in *A* and *B* (Figs. 1 and 2). The upper part of the basin is raised in the form of a rectangular clamping, to which another rectangular pipe is fitted, and bent on one side in the shape of a weir, to fit at *M* with the water-closet pipes from the different stories of dwellings. This junction is facilitated by a clamping in the upper part The apparatus can be in glazed stone, or enamelled metal. A grated box of a square shape is placed in the apparatus, and the four posts of it slide in grooves in the sides of the rectangular pipe and in the bottom of the basin. The support *a* of this movable box, which is placed before the entrance for the water, is smaller in size, so as to slide in the corresponding groove and allow the box to be always replaced in the same manner. This box always presents two faces at an angle to the direction of the water in the pipe—an arrangement which facilitates the work of dilution, as the solid matters are never in too thick a layer, and even in case of excess the water keeps its passage towards the angles. The movable box is formed of four vertical supports joined to the lower part and bound together above by three sets of ties. Two of the supports have a crosspiece *P* for raising the box and taking it out of the basin. The sides of the box are composed of a grating in strong iron wire 0.004 meters in diameter, and having an interval between each of 0.01 metres parallel to the movement of the water. The opening on the top for cleaning, etc., is closed by a lid in sheet iron with key. The working of the apparatus is simple. The solid matters coming from the water-closets and the house slops pass by pipe *M* and fall into the diluting box, into which all the waters of the premises fall. The grating of the box is arranged to facilitate the entry of water, but to prevent solids from leaving. There can be no choking, as the circular basin placed above the draw-off pipe allows the liquids to escape, in case the diluting box should contain too much matter. The sewage is effected as follows: The sewage matter comes to the only outlet in the front wall, and from here the pipe is simply prolonged under the street to the branch of the collecting drain.

In the sewer, this drain under the apron is composed of a series of pipes in glazed stoneware (fig. 5). For the purpose of providing for excessive sewage in the collecting drain in heavy rains, etc., an outlet or oblique overflow pipe *M* (fig. 5) is placed in the pipe before it reaches the sewer, and the outlet is terminated by a stop siphon placed somewhat above the level of the waters of the sewer.

Each pipe, which has a special duct, has an opening *a b* opposite the latter, which serves for clearing out the bend, etc.

NEW YORK AND BROOKLYN BRIDGE.

(*Continued from page* 345.)

WIRE ROPES FOR FOOT-BRIDGE.

According to the specifications there were two galvanized steel ropes for the foot-bridge, each rope weighing 12 lbs. to the foot and measuring scant $2^5/_8$ in. in diameter, and having a breaking strength of not less than 340 net tons. The specifications stated:

"The lengths are uneven, as follows: One rope to be 3,625 ft. long, the second rope to be 3,688 ft. long.

"Three galvanized steel cradle ropes, each weighing 9 lbs. per foot, and to be full $2^1/_4$ in. in diameter. Each of these ropes has a length of 3,625 ft. and a breaking strength of not less than 18 tons.

"One galvanized steel carrier rope, weighing 3 lbs. per foot, and being about $1^3/_8$ in. in diameter having a length of 3,710 ft., and a breaking strength of not less than 60 tons.

"Four galvanized steel working ropes (for pulling over wires), weighing $^7/_8$ lb. per foot, and being $^3/_4$ in. in diameter, each rope having a length of 3,800 ft., and a breaking strength of not less than 18 tons.

"Four galvanized steel pendulum ropes (for separating strands), weighing $^3/_4$ lb. per foot, and having a diameter of $^1/_3$ of an inch. Each rope has a wire core, and a length of 3,700 ft.

IRON ROPES.

"Two galvanized iron hand-rail ropes, composed of seven wires to the strand, No. 17 gauge, with a tarred manilla core and ordinary lay, not too long. Length of each rope, 8,500 ft.

"Under-floor foot-bridge guys. They have an aggregate length of 10,868 ft., and a thickness of 11-16 of an inch. The rope to be composed of six strands around a hemp center, and to weigh $^3/_4$ lb. to the foot. Each strand must have seven wires, No. 15 gauge, galvanized, and made of best (*b. b.*) charcoal iron.

"Suspender cords, weighing 9 ft. to the pound, and consisting of one strand of seven No. 14 galvanized charcoal wires. An aggregate length of 8,000 ft. will be wanted.

CONSTRUCTION OF ROPES.

"The foot-bridge ropes will be composed of six strands, laid around a central core, all of equal size. The outside strands will contain 19 wires each, but the core, in place of being a strand, will be a regular laid rope, composed of six strands and a core, each containing seven wires. The wires of this rope core must be of the proper size, so as to give it the same diameter as the strands. The lay of the rope core must be the same as the lay of the outside strands, which may be either right lay or left lay. The size of the various wires must be so proportioned as to give a total weight of 12 lbs. per foot. No projecting wires can be allowed in the strands. The strands must be round. The lay of these ropes will be that known as long lay; that of the strands in the rope being not less than one turn in $17^1/_2$ in., nor more than one turn in $18^1/_2$ in.

"The construction of the cradle ropes will be similar, viz.: Six outer strands around a center. Each outer strand will contain 19 wires, and the central strand will be the same as the outer ones, differing in that respect from the foot-bridge ropes. The size of wires must be proportioned, to give a weight of 9 lbs. per foot to the rope. The lay of these ropes will also be long lay; not less than one turn in $14^1/_2$ in., nor more than one turn in $15^1/_2$ in.

"The carrier rope will be composed of six strands around a wire center, each strand contain-

TABULAR STATEMENT, GIVING THE RESULTS OF TESTS MADE OF SAMPLES OF GALVANIZED STEEL WIRE, SENT WITH THE BIDS FOR FURNISHING THE CABLE WIRE FOR THE EAST RIVER BRIDGE.

EXPLANATION OF THE TABLE.

Column 1 gives first, the marks placed upon the coils or bundles of wire by the bidders, and which were upon them when received; secondly, "End A, and End B" indicate test pieces that were taken from opposite ends of the same coil; thirdly, wires 1, 2 and 3 indicate the number of pieces taken, consecutively, from the same ends of the coil. Column 2 gives the strain, in pounds, at which the respective wires broke. Column 3 gives the relative breaking strain, per square inch, of solid steel section. Column 4 gives the length of pieces under test. Column 5 shows the total elongation, or stretch, at the time of breaking, in ten thousandths of the lengths of the piece tested. Column 6 gives the permanent elongation, in one hundred-thousandths of the length of the sample tested, produced by increasing the strain from 1,200 to 1,600 lbs., and shown on reducing the strain to 1,200 lbs. Column 7 gives the permanent elongation in one hundred-thousandths of the whole length of the sample tested, produced by the increase of strain from 400 lbs. to 1,600 lbs., and shown on reducing the strain to 400 lbs. Column 8 gives the modulus of elasticity in pounds. Column 9 gives the diameter of the wire at the point of fracture, after the zinc is removed, in thousandths of an inch. Column 10 represents the bending tests. "Continuous ½ in." indicates that the wire was bent continuously around a rod ½ inch in diameter without breaking: "4—½ in." indicates that the wire was coiled four times around the rod when it broke. Column 11 indicates the diameter of the curve which a piece of wire would assume when left to lie loosely on the floor. Column 12 gives the weight of each coil, as furnished by the bidders.

1	2	3	4	5	6	7	8	9	10	11	12
Samples.	Ultimate Strain in lbs.		Length Tested.	Ultimate Elongation in dec. of length.	Permanent Elongation.		Modulus of Elasticity. Lbs.	Diameter Steel Section at Fracture. Inch.	Bending Test. Turns—Diam.	Curve in Wire.	Weight of Ring. Lbs.
	Per Wire.	Per Square Inch Steel Section.			From 1,200 to 1,600 in dec. of length.	From 400 to 1,600 in dec. of length.					
J. LLOYD HAIGH.											
Coil 2—End A—Wire 1	3,815	170,628	5 ft.	.0380	.00000	.00000+	29,817,067	.147	½ — ½ in.	Straight.	69½
" 2 " B " 1	3,950	178,728	5 "	.0470	0	0	29,670,495	.152	Continuous ½ in.		
" 2 " B " 2	3,675	166,169	100 "	.0233	.00001+	.00001+	29,552,941	.162	"		
" 3 " A " 1	3,945	174,177	5 ft.	.0370	0+	.00001	29,047,565	.160	"	Slight Curve.	59½
" 3 " B " 1	4,085	181,580	5 "	.0440	0+	0	29,437,311	.160	"	"	
" 3 " A " 2	3,815	167,647	100 "	.0171	0½+	.00001+	28,815,797	.153	"		
" 6 " A " 1	4,010	182,450	5 ft.	.0400	0	0+	29,353,968	.156	½ — ½ in.	Straight.	55
" 6 " B " 1	3,835	175,460	5 "	.0270	0+	0	29,709,247	.164	"	"	
" 6 " A " 2	4,025	182,058	100 "	.0233	.00001	.00001+	29,371,233	.154	"	"	
" 7 " A " 1	3,940	176,570	5 ft.	.0490	0+	0	29,386,675	.155	"	Straight.	54½
" 7 " B " 1	3,835	174,729	5 "	.0370	0	0	29,585,455	.152	"	"	
" 7 " A " 2	3,880	173,881	100 "	.0360	.00001	.00001½	29,290,610	.161	"	"	
CLEVELAND ROLLING MILLS.											
Coil A—End A—Wire 1	3,900	180,447	5 ft.	.0360	.00002	.00003	28,917,715	.161	Continuous ½ in.	6 feet Diameter.	63
" A " B " 1	3,845	177,652	5 "	.0400	.00002+	.00002	30,002,233	.138	4 — ½ in.	6 " "	
" A " A " 2	3,740	172,984	100 "	.0210	.00002	.00002½+	29,840,187	.149			
" B " A " 1	3,985	182,576	5 ft.	.0400	0+	0+	30,142,026	.144	5 — ½ in.	12 feet Diameter.	66½
" B " B " 1	3,935	181,554	5 "	.0420	0	.00002	29,387,465	.145	Continuous ½ in.	8 " "	
" B " B " 2	3,805	175,187	100 "	.0215	.00001	.00001	29,896,883	.148			
WASHBURNE & MOEN.											
Coil 1—End A—Wire 1	3,865	184,019	5 ft.	.0360	.00001+	.00001+	29,757,300	.134	Continuous ½ in.	10 feet Diameter.	71½
" 1 " B " 1	3,755	179,302	5 "	.0170	.00001	.00001	29,384,702	.147	" ½ "	10 " "	
" 1 " B " 2	3,675	175,164	100 "	.0083	.00001	.00001	28,887,006	.133			
" 2 " A " 1	3,715	174,597	5 ft.	.0300	.00001	.00001+	29,558,346	.142	Continuous ½ in.		58
" 2 " B " 1	3,760	175,955	5 "	.0450	0+	.00001	29,712,146	.137	" ½ "		
" 2 " B " 2	3,620	169,706	100 "	.0250	.00001½—	.00001¾	29,263,483	.140	" ½ "		
SULZBACHER, HYMEN, WOLFF & CO.											
Coil B & C—100—End A—Wire 1	3,905	178,996	5 ft.	.0440	0	0	29,900,587	.151	2 — ½ in.	Nearly Straight.	54
" " " " B " 1	3,725	170,745	5 "	.0300	0	0+	29,383,077	.154	" "		
" " " " A " 3	3,685	167,807	100 "	.0182	.00001	.00001	29,190,949	.162	1 — ½ in.		
Coil B & C—200—End A—Wire 1	3,915	179,454	5 ft.	.0400	0	0+	29,103,238	.150	Continuous ½ in.	Straight.	41½
" " " " B " 1	3,945	179,833	5 "	.0400	0	0+	30,389,946	.139	" "		
" " " " A " 2	3,845	174,913	100 "	.0317	0+	.00001	29,501,251	.154	" "		
JNO. A. ROEBLING'S SONS CO.											
Bundle O.											
Coil 4—End A—Wire 1	3,985	179,019	5 ft.	.0370	0	0+	29,948,800	.159	½ — ½ in.	Nearly Straight.	69
" 4 " B " 1	3,805	174,706	5 "	.0480	0+	0+	30,207,151	.154	½ — ½ "		*
" 4 " A " 2	3,210	143,816	100 "	.0054	.00001	.00002	29,578,709	.163	4 — ½ "		†
" 4 " A " 3	3,150	143,090	100 "	.0045	0+	.00001+	29,184,524	.161	" ½ "		
" 5 " A " 1	3,675	171,098	5 ft.	.0410	.00001	.00001	30,231,929	.151	4 — ½ "		70
" 5 " B " 1	3,845	171,573	5 "	.0345	.00001+	.00001	28,788,619	.158	2 — ½ "	12½ ft. Diameter.	
" 5 " B " 2	2,800	125,321	100 "	.00375	.00001—	.00001+	29,195,923	.167			
Bundle R.											
Coil 1—End A—Wire 1	3,940	178,163	5 ft.	.0375	0+	.00001—	29,749,408	.142	4 — ½ in.	12½ ft. Diameter.	54
" 1 " B " 1	3,845	178,512	5 "	.0380	.00001+	.00001	29,952,929	.139	Continuous ½ in.		
" 1 " B " 2	3,760	173,177	100 "	.0215	.00001	.00001+	29,524,237	.135	" ½ "		
" 3 " A " 1	3 575	161,658	5 ft.	.0360	0+	.00003—	29,747,408	.134	Continuous ½ in.		55
" 3 " B " 1	3,400	158,073	5 "	.0380	.00001	.00003+	29,057,511	.141	" ½ "	8½ ft. Diameter.	
" 3 " B " 2	3,275	150,371	100 "	.0235	.00001—	.00001	29,432,610	.130	1 — ½ in. with curv.		
JOHNSON & NEPHEW.											
Bundle A.											
End A—Wire 1	4,425	206,170	5 ft.	.0440	.00004—	.00005		.142	Continuous ½ in.	5 ft. Diameter.	114
" B " 1	4,055	196,008	5 "	.0430	.00005	.00009		.148	" "		
" A " 2	4,305	199,884	100 "	.0310	.00007	.00016		.143	" "		
Bundle B.											
Coil 1—End A—Wire 1	3,475	166,534	5 ft.	.0500	.00007	.00009		.135	Continuous ½ in.	5 ft. Diameter.	54
" 1 " B " 1	3,415	164,836	5 "	.0620	.00005	.00012		.131	" "		
" 1 " A " 2	3,515	168,150	100 "	.0540	.00005+	.00010		.129	" "		
" 2 " A " 1	3,485	166,301	5 ft.	.0690	.00005	.00009		.134	" "		53
" 2 " B " 1	3,465	163,027	5 "	.0630	.00008—	.00014		.139	" "		
" 2 " A " 2	3,540	168,445	100 "	.0504	.00006	.00010		.140	" "		
CAREY & MOEN.											
Bundle D.											
End A—Wire 1	2,755	129,675	5 ft.	.0075	.00002	.00002	29,418,025	.133	Continuous ½ in.	Bends.	46
" B " 1	3,085	188,109	5 "	.0420	.00001+	.00002	31,261,041	.155	" "	"	
" A " 2	2,700	126,814	100 "	.0058	.00013	.00014		.125	" "	Irregular Bends.	
Bundle E.											
End A—Wire 1	4,215	194,227	5 ft.	.0080	0	.00001	29,922,078	.146	" "	Nearly Straight.	35
" B " 1	4,125	191,151	5 "	.0310	.00001	.00001	30,051,705	.154	" "	" "	
" B " 2	4,085	190,843	100 "	.0225	0+	.00001	29,813,625	.153	" "	" "	
Bundle F.											
End A—Wire 1	3,175	150,304	5 ft.	.0100	.00001—	.00002	30,229,802	.138	" "	" "	49½
" B " 1	3,825	180,256	5 "	.0350	0+	.00002	30,740,887	.151	" "	" "	
" A " 2	2,945	137.918	100 "	.0045	.00001	.00002	29,546,536	.153	" "	" "	
Bundle G.											
End A—Wire 1	3,785	177,143	5 ft.	.0360	0+	.00002+	30,194,381	.153	" "	" "	41
" B " 1	3,780	175,022	5 "	.0390	0+	.00002+	30,046,872	.155	6 — ½ in.	" "	
" A " 2	3,705	173,090	100 "	.0234	.00001+	.00001+	29,662,190	.160		" "	
HENLEY.											
Bundle 1—End A—Wire 1	3,425		5 ft.	.0130						5 ft. Diameter.	
" 1 " B " 1	3,305		5 "	.0090						5 ft. "	
" 2 " A " 1	3,385		5 "	.0340						" "	
" 2 " B " 1	3,325		5 "	.0250						4 ft. "	
" 3 " A " 1	2,800		100 "	.0090							

DECEMBER, 1876.

* Slipped in jaw. † Slipped at 1,600 lbs.

C. C. MARTIN, W. H. PAINE, *Assistant Engineers.*

ing 7 wires, No. 9 gauge. The lay of the rope will be moderately long, about one turn in 9 in.

"Each working rope will be composed of six strands of seven No. 14 wires each, laid around a central core of best tarred hemp. As these ropes are intended for running ropes, they must have a moderately short lay of about one turn in 6¼ in.; and, as these ropes are to be spliced into endless ropes, they must all have the same lay.

"The pendulum ropes will be composed of seven No. 15 wires in each strand, with a wire center, and made in the same way as the carrier rope. The lay will be moderately long, about one turn in 6¼ inches. * *

STRENGTH AND QUALITY OF STEEL WIRE TO BE USED.

"All the steel ropes are to be made of the best quality of hardened and tempered galvanized 'crucible cast-steel' wire. No 'Bessemer' wire, or 'Siemens-Martin' steel wire, or 'Open Hearth' steel wire can be accepted. The strength required is at the rate of 160,000 lbs. per square inch of section. This rate is not excessive, and can easily be obtained by manufacturers of such wire. It requires, for instance, that No. 7 wire, weighing 12 ft. to the pound, shall have a breaking strength of 3,966 lbs. No. 8 wire, weighing 15 ft. to the pound, shall have a breaking strength of not less than 3,175 lbs. No. 9 wire, weighing 17 ft. to the pound, shall have a breaking strength of not less than 2,384 lbs., etc.

"Specimens with this breaking strength must stretch at least 2 per cent., and must have a limit of elasticity not less than ⅗ of the breaking strength—that is to say, a sample of wire stretched up to ⅗ of its breaking strength must recover itself without any appreciable set. When the manufacturer has prepared a sufficient quantity of wire for these ropes, he must notify the engineer or his authorized assistant, who will test a sufficient quantity of the wire to see if it comes up to the above standard. He will continue these tests from time to time in order to insure a uniformity throughout the manufacture. All these tests will be made after the wire is galvanized, and not before. The manufacturer must furnish the testing machine for this purpose. The necessities of the case require that all our ropes must be suspended with very small deflection. The strain is consequently very great, arising as much from their own weight as from the load placed upon them. An increase in the size of the ropes would, therefore, increase the margin of safety but little, and we are compelled to rely entirely upon the superior quality of the material used in order to be safe.

"The rates of strength in Nos. 7, 8 and 9 wires are given as examples. The precise weight of wir must be determined by the manufacturer, so as to produce the weight per foot of rope specified. Where nothing is said to the contrary, the Birmingham wire gauge is understood to be standard.

"All the steel wire used in these ropes must be properly soldered with brass solder; no other kind of joint can be allowed. This joint must be galvanized, so that there is no interrupion in the continuity of the zinc covering. In no case will it be permitted to stick in the ends of the wire loose in place of the proper joint. Inasmuch as the size of wire used is very coarse, the rings will be small and joints very plenty. It is, therefore, required that rings weighing not less than 60 lbs. shall be used.

"In order to diminish the stretch of these ropes as much as possible, it is desirable they should be laid up under great strain, at least one-tenth of the breaking strain. This strain must be uniform on all the strands.

"All these ropes, as well as strands, must be made in one piece, of the whole length required, and in no case can the splicing of a whole strand be permitted.

GALVANIZING.

"All the wires used in these ropes must be completely and thoroughly galvanized. This is a very important matter, as the durability of the ropes depends entirely upon it. The ropes will be subjected to the direct influence of salt air, not only during their temporary use, but also when used as stays in the permanent work. Some of the smaller ropes will even be dragged through the salt water. The galvanizing must, therefore, not only be very perfect on the wire, but great care must be taken not to scrape any off in manufacturing the ropes.

"The inspector appointed for the trustees will inspect the wire before it is laid in the rope, and reject all rings which show uncovered spots, scales, cracks after bending, or other imperfections in the coating of zinc.

"Another important point—for the consideration of the manufacturer alone—is to have the steel wire galvanized in such a manner as not to diminish the temper, hardness or breaking strength thereof. The trustees of the bridge are fully protected in this respect, because the wire will be tested only after it is galvanized.

"Each of the four working ropes, as described in paragraphs 2 and 3, is to be marked by the manufacturer with a prominent mark, such as paint, or a wire wrapping, to designate the point at which these ropes will rest on the top of the New York tower. This point will come at a distance of 1,070 ft. from the outer end of the rope as it lies coiled on the reel, or its equivalent distance of 2,780 ft. from the inner end of the rope.

The ropes will be wanted in the following order: First, the four working ropes; next, the carrier rope; next, one cradle rope; next, two foot-bridge ropes; next, the two cradle ropes; next, the under-floor guys and suspenders; next, the hand-rail ropes; and, lastly, the four pendulum ropes. All these ropes must be delivered in three months after the letting of this contract.

All the ropes must be mounted or coiled on strong vertical reels, with extra thick woolen sides, provided with an opening for a horizontal spindle on which to revolve them. The side of the reel must be of extra width, to admit of the application of breaks in paying off. Reels must be made of extra strength and size, so as not to be smashed by the great weight of the ropes in handling and moving them. The reels will be paid for extra. In no case can these ropes be received in a loose coil, because they have to be transported through crowded streets it a city. A coil is, moreover, unsuited in other respects for handling the rope." * * *

REPORT OF ASSISTANT ENGINEERS MARTIN AND PAINE ON THE RESULT OF THE TESTS.

PIER 29, EAST RIVER,
NEW YORK, Dec. 16, 1876.

Col. W. A. Roebling, Chief Engineer New York and Brooklyn Bridge:

DEAR SIR: We herewith present the results of tests made by us in accordance with your instructions, of the samples of wire furnished by parties who have presented proposals to furnish the steel cable wire required for the construction of the East River bridge, as called for by the published specifications.

We have endeavored to make the tabulated results so full and complete as to obviate the necessity of writing out a long detailed statement.

All of the parties proposing to furnish this wire were present, in person or by representatives, during all or a portion of the time employed in making the tests, excepting Mr. Henley.

A few tests of Mr. Haigh's wire were made before the general invitation to all the bidders was given. The results of these tests are submitted on a separate sheet, as another complete set of tests of his wire were made in the presence of the other bidders, and are included in the tabulated results.

All of which is respectfully submitted.

C. C. MARTIN,
W. H. PAINE.

CABLE MAKING.

From a paper read by Mr. Francis Collingwood before the American Society of Civil Engineers we take the following extract:

"By request of Col. Paine, whose time has been completely taken up by other matters since the cables were completed, I present also the following record of work accomplished in his department. * * *

"During the winter of 1876-7 the foot-bridge was completed, the contract made for the cable wire, and all the necessary preliminaries settled.

"Among these, one of the most difficult was found to be the adjustment of the four wires used as guides in adjusting the cable wires. It was at first thought to be sufficient to fix them by the deflection of the center span alone; but it was found that the land spans hung at deflections totally different from each other, and, after considerable trouble, it was found to be due to slight differences in diameter and weight of the various lengths of wire.

"To overcome this, a large number of coils were stretched out, measured and weighed, and enough selected of uniform size and weight to make up the length required.

"After this the weather had to be watched for periods of perfect calm, when no sun was shining, during which times only adjustments could be made. The whole time thus occupied was about six weeks.

"On the land spans the line of reference was a tangent to the curve, whose position had been calculated; and on the center spans it was a level line tangent to the lowest point of the curve. Allowances were made for the temperature ruling at the time

"Another point which was worked up during this winter, was the method of joining the coils of wire together. The coupling finally adopted gave from 95 to 98 per cent. of the full strength of the wire, with the coupling ungalvanized; and after galvanizing the joint the *full* strength was developed.

"The wire at first specified had a diameter before galvanizing of about 0.167 in. diameter, being Birmingham gauge, No. 8 full. The coupling was made from Bessemer steel wire, 0.281 in. diameter, and was 1 ½ in. long. This was drilled longitudinally, and then the hole was reamed out for about one-fourth of the length in at each end, so as to taper from the full size of the wire at the ends to about the diameter of the bottom of the screw thread at the inner end of the taper. Then one end was tapped with a right-handed, and one with a left-handed tap. Dies of a similar shape to the coupling were made for cutting the threads on the wire.

"At first considerable irregularity in the strength of the joints was observed, and it was found to be due to the dies changing shape in hardening to an amount reaching sometimes $\frac{1}{100}$ of an inch. This was overcome by making an adjustable die so as to secure uniformity in size.

"The first cable wire was carried across the river May 29, 1877, and from this time cable making was continuous. At first an unforseen difficulty was encountered from the unscrewing of the couplings while the wire was in transit. After considerable experimenting a plan was adopted which overcame the trouble perfectly. This was the simple device of clipping the ends of the wires diagonally so that when the coupling was screwed home they would overlap and effectually prevent the wires from turning separately in the coupling.

"Simultaneously with this came the training of the men who adjusted the wires. The adjustment had, of course, to be progressive—first a land span, then the center span, and finally the opposite land span.

"The differences in weight of similar lengths of wire showed itself here often by making one quarter hang high and another low. The adjusters were in such cases instructed to make the differences equal, so as to balance each other, thus securing uniform lengths and a perfect adjustment. Marks were made on the wire with paint as soon as an adjustment was complete at any point, so that slipping could be at once detected.

"The first strand was completed and lowered into position and attached to the cable bars on July 14, 1877. As it would be impossible to *lengthen* a strand, all strands were made by preference a trifle too long, and adjusted to length after lowering. To allow of this the shoes over which the wires pass at either end have a slot through them instead of a round hole, and segments are inserted back of the pin to secure the exact length.

"The lowest or *first* strand in each cable was adjusted in the same manner as the guide wires had previously been; and the succeeding ones were adjusted from these by calculating differences in elevation due to their own particular lengths. The differences in *length* were due to different positions in the saddles, different points of attachment at the cable bars, cradling of the cables, etc, and it will be seen that the process of adjustment was an exceedingly delicate one.

"It was usually done very early in the morning to avoid differences in temperature.

"When the strands were finally brought together for wrapping, each one came to its place admirably, much to the satisfaction of all concerned.

"The experience on the first strands showed that there was no difficulty in getting the requisite quality of wire, and it was then decided that as larger wire could be had which would comply with the specifications, and as its use would facilitate the work, its size should be increased from No. 8 to No. 7 wire, which is about 0.1875 in. diameter.

"This gave, instead of 14 ft. to the pound, about 11 ft. to the pound, and made a material difference in the length to be run out.

"The speed of the traveler averaged 5½ ft. per second, and as the wire ran out at twice this rate, 11 ft. of wire were run out per second by one, or 22 ft. when both travelers were working.

"In order to keep the strands distinct, and also to prevent chafing, they were, after completion and before lowering, seized throughout their length, at points 2 ft. 4 in. apart, by about 5 turns of No. 14 annealed wire. These seizings were removed always in advance of core making or cable wrapping.

"After 12 strands of a cable were completed the central 7 (being the ones which were to occupy the center of the finished cable) were brought to-

gether compactly to form the cable core. This was done by the aid of screw clamps: the outer strands being pounded with wooden mallets so as to distribute the wires uniformly around the central one of all. A fresh seizing was put on the core at short distances as the compressing progressed.

"Everything went on well until June 14, 1878, when the fifteenth strand of the up-town cable was in process of lowering. By an unfortunate fouling of a wire rope, causing its rupture, the strand fell, killing two men, and causing a total loss of the strand.

"The last wire in the cables was run over Oct. 5, 1878. The next operation was to draw all the strands in each cable together at each end to a true cylindrical form. This was done, and heavy clamps put on at 21½ ft. from the anchor bars. It must be borne in mind that at the point of joining with the anchor bars the strands spread to a rectangle nearly 5 ft. square; hence the necessity for permanent clamps at the points mentioned.

"Regular work on cable wrapping began Oct. 25. The wire used for this purpose was charcoal iron wire No. 10, drawn a little hard and galvanized. As the wrapping was done, every part of the cable was saturated with linseed oil.

The coils of wrapping wire were joined together by a twist splice. The two ends to be joined were tapered for about 4 in., then twisted together, and the whole swaged. This left but a slight enlargement, which passed readily through the wrapping machine. Every joint was finally galvanized. The operation of cutting the seizings of the core and flatting out the external strands, etc., preceded the final wrapping also—the ends of the seizings being pulled out with pincers and hooks. Clamps were screwed on in advance to bring the cable wires into close contact, and the wrapping wire was put on under considerable tension. It is calculated that the friction between the wires is so great that if cut it would be impossible to pull out 10 ft. of any cable wire, as the friction in that length would more than equal its tensile strength.

"The speed of wrapping was from 16 to 20 ft. of cable per day per gang, 36 ft. being an extreme limit.

"The work was completed finally on Feb. 17, 1879, or in about 15 months less time than was thought possible when it began.

"During the summer of 1878 the suspender ropes were all cut to length, and sockets attached. As the ropes are all of twisted wires, it was necessary (to secure accurate lengths) that they should be measured under strain. Accordingly one socket would be attached, the rope uncoiled and stretched out, and the socket put over a pin; then, by an ingenious parallel motion clamp, made to grip the rope without injuring it, a strain of about 6 tons would be put upon it, and the requisite length marked off. The old method of cutting was by a chisel and sledge, and was very tedious; it always separated the wires, and caused much trouble in inserting them into the socket. To obviate this Mr. Abbott, assistant in charge, designed a circular cutting shears, which, instead of separating, compressed the wires together, and resulted in a saving of an hour on every socket. It ought here to be said that the clamp mentioned, and also the machine for clipping the ends of the wire diagonally, were designed by Mr. Abbott.

"The method of fastening pursued in every case was to let the wires project a little beyond the cone of the socket, then to untwist and separate them as widely as possible; next to drive in all the large iron pins (with a taper equal to that of the socket, and length a little less) that could be inserted: then to follow these by shorter and smaller pins, until it was impossible to drive in any more. The wires were then bent over upon the heads of the pins, and finally all poured full of lead to keep out the weather.

"As the *strongest* wires would be those approaching nearest to the minimum of ductility allowed by the specifications, they would frequently break under this bending test, which was much more severe than the specifications required (being almost a right angle, and accompanied by a blow). The number broken reached from one-eighth to one-fourth of all; but as the bending down of the ends was not relied upon for strength, no harm can ensue. The friction of the pins is entirely sufficient to break the rope.*

"The cables of the foot-bridge were made of a much harder wire, and even more of them broke in putting on the socket, but no sign of yielding has ever occurred, although they are subjected to about three times the strain, in proportion to their strength, that will ever come upon the suspenders.

"The strain put upon each rope, when cut to length, was nearly up to its full working strength, and not a socket yielded in the least. These facts are mentioned to show that with proper care this method of fastening is absolutely secure.

"The bands for attaching the suspenders to the cables have all been made, and will probably be put in place during this summer.

"I have thus given a brief summary of the leading facts concerning this portion of the work; but it would seem desirable that a statement should be made of some of the results of our experience in the use and testing of steel:

"1st. Referring to steel wire, it has been satisfactorily demonstrated that no satisfactory test of the elastic limit or amount of stretch can be made on wire drawn and coiled in the ordinary way, on account of the set induced by coiling.

"2d. The elastic limit of straight wire was found always to be more than 50 per cent. of the ultimate strength.

"3d. There is no difficulty in getting steel wire that shall lay out straight when loosened from the coil. It simply requires that it be led straight a sufficient distance from the galvanizing trough to be cooled before coiling, and that the coils be not made too small. Our coils were 4½ ft. in diameter.

"4th. Galvanizing was found to increase the strength of freshly-drawn wire *about* 15 per cent. It was a common thing for ungalvanized wire which fell below the required strength to come up to it after a week or two, the gain being nearly 5 per cent. Even galvanized wire would gain in strength slightly by rest. The only explanation of this is the accommodation of strains induced by the drawing. In the case of galvanized wire, however, there may be a remnant of occluded hydrogen, due to the galvanizing process, which is known to have a temporary weakening effect.

"5th. Steel wire can be had in quantity of a tensile strength of 160,000 lbs. per sq. in., with a stretch of 2½ per cent. in breaking in 100-ft. lengths; and of 4 per cent. in breaking in 1-ft. lengths; and being capable of being coiled continuously around a half-inch bar.

"6th. The steel required to give this strength in wire of sizes No. 7 and No. 8 B. W. G., when in sizes such as are required for *ordinary bridge* members, has a strength of only 70,000 lbs. to 75,000 lbs. per sq. in., with an elastic limit of 40,000 lbs., and a stretch of 10 per cent. on full length of bar, or 15 per cent. on samples 1 ft. long.

"7th. Tests by impact, made by allowing weights to fall lengthwise, of wire having a tensile strength of 3,400 lbs. per wire, gave results as follows:

"A 100 pound weight falling freely 3 7-10 ft. broke a wire 1 ft. long. The same weight fell 34 ft. to break a wire 100 ft. long.

"The amount of work done in the first case by the weight was 370 ft. pounds; and in the second case 3,400 ft. pounds.

"8th. A logical deduction from these experiments is that the longer the members in a bridge the *safer* it becomes to use high grade material; and, while it is absolutely safe to use wire such as was used in the cables of the East River bridge in members of that length, it would be totally *unsafe* to use anything approaching such material in the trusses of the same.

"In making specifications recently for steel for the bridge trusses the requirements as to quality were those mentioned in the sixth head above. Previous to this bids had been asked on the basis of wrought iron, for the reason that only a year ago it was questionable whether proper shapes could be produced in this country in steel. This difficulty having been overcome, and the continued tests of steel by Col. Paine having more fully demonstrated the desirability of using steel, Col. Roebling and the trustees decided to ask bids anew for an all steel bridge. The field is a new one, and the engineering department has endeavored to make use of the latest knowledge on the subject, and at the same time be entirely safe."

(TO BE CONTINUED.)

*Tests since made on full length ropes have proved this to be true, and also that the wire, both in ductility and tenacity, was above the requirements of the specifications.

EXPLOSIVE COMPOUNDS.

Two of the most innocent substances in the world are cotton and glycerine. Each, however, is at the head of a very explosive family. Like ancestors of well-marked character, each has stamped a well-defined character on its descendants. Effects are produced by the cotton explosives which cannot be obtained by the glycerine family, and the glycerine explosives give results unobtainable by the gun-cotton family. Gun-cotton, as its name implies, is more adapted for warlike purposes, while nitro-glycerine and its derivatives are better suited to mining operations.

Nitro-glycerine is obtained by placing a quantity of glycerine in a bath composed of one part of nitric and two of sulphuric acid. During the process a high temperature is developed, and the vessel in which the mixture is formed requires to be kept in ice water. Nitro-glycerine thus obtained is colorless, and has a sweet aromatic taste and the consistency of olive oil. It congeals at 8° Centigrade, but explodes by a shock or jar, or by being raised to the temperature of 180° Centigrade by an electric battery or fulminating preparations, such as the fulminate of mercury. Its explosive power is said by artillerists to be six times that of powder, its projectile force four times greater. In its simple state it was too dangerous for use, owing to its liability to explode by a jar. Near Llanberis, in Wales, a cart conveying some to the slate quarries happened to strike one of the wheels against a stone in the rough road, and cart, horses and driver were seen no more. A leaky can had let some escape on the floor of a railroad car; a porter accidentally threw a piece of slate on it, and the car was wrecked. The British Parliament prohibited its use for a time. But its advantages over powder in all mining operations were so marked that its manufacture could not be stopped. The thing to be done, then, was to bring it more under control.

As usual, accident put men of science on the right track. Some workmen noticed that it lost its explosibility when mixed with a certain kind of sand. Nobel was led by observation of this fact to form the compound named dynamite, which is simply nitro-glycerine, absorbed by sand. He used for his base a silicious sand found at Oberlobe, in Hanover. During the siege of Paris the French engineers, not being able to obtain this (*Kieselguhr*), employed coke dust from the gas works with success, and named the compound Randannite. The first dynamite manufactured by Nobel, his "No. 1," contained 75 parts of nitro-glycerine and 25 of silicious sand. Various proportions are used, according to the use to which the compound is destined. The Austrian engineers employed the low figures of 40 or 50 per cent. nitro-glycerine absorbed in sawdust. They argued that it was better to increase the volume of the explosive substance than to incur risk from using it in a more concentrated form. It was formed into cartridges for the sappers of the army to carry on their persons, the proportion being 35 per cent. nitro-glycerine and 65 sawdust. In mines, where it is necessary that the effective charge should occupy as small a space as possible, the proportions are inverted. Then some destructive geniuses invented fulminative and other compounds. All these are styled dynamites with an inert base, for the substances with which the nitro-glycerine is mixed contribute nothing to the explosive power. The next step was the production of dynamites with an active base. In them the nitro-glycerine is absorbed by carbonate of magnesia, azotate of soda, nitrate of potassium, and the like, which exercise a direct action on the explosion by utilizing the portion of oxygen set free by the decomposition of the nitro-glycerine. The French dynamites contain one of these salts mixed with sawdust or Tripoli stone. Nobel's dynamite "No. 2" contains niter, resin and coal dust. In the war the Germans used a compound called the stone breaker. This is made in the factory of Krebs, at Kalk, near Cologne, and consists of 52 parts in weight of nitro-glycerine, 30 of silicious sand, 12 of powdered anthracite, 4 nitrate of soda, and 2 of sulphur according to one process, while another formula is 42 parts of nitro-glycerine, 25 nitrate of soda, 4 sulphur, and 29 of coal dust, sawdust and sand.

An Austrian engineer was next seized with the bright idea of mixing nitro-glycerine and gun-cotton. He called his new compound pyroxyline dynamite, and used 75 per cent. of nitro-glycerine and 25 per cent. of gun-cotton. This put Prof. Abel on his mettle, and he threw his talents into inventing glyoxyline dynamite, a mixture of gun-cotton with niter saturated in nitro-glycerine. Nobel, not to be outdone, invented his explosive gelatine, consisting of 95 per cent. of nitro-glycerine and 5 per cent. of collodium cotton. This article is twice as strong as his dynamite "No. 1." Nobel was now in the vein, and he next devised his gelatinous dynamite, containing 86.40 of the nitro glycerine, 9.60 of powdered gun-cotton, and 4 of camphor. This compound will resist the most violent shocks. It is a gelatinous mass, elastic, transparent, of a pale yellow color. It can be cut with a knife and subjected to pressure without any nitro-glycerine exuding. It preserves its vir-

tues during long immersion in water, and when frozen forms a solid mass like candy sugar. It will not explode even when struck by a rifle ball at twenty yards' distance. It burns in fire quietly without exploding, just as ordinary dynamite does.

Dynamite being now rendered non-explosive by shock or by fire, requires to be exploded by some fulminate or by electricity. The fulminates of mercury or of silver, or chlorate of potassium are the means generally used. In very cold weather, when the dynamite is frozen, it has to be thawed, but it is only necessary to thaw one cartridge in order to set off the whole charge. The effects are almost incredible. Dynamite exploded on a sheet of iron does not break it, but knocks a hole through it; exploded on the ground, it produces a regular crater. A charge of three kilograms of dynamite placed on a plate of iron five centimeters thick and one meter square made a hole seven centimeters in diameter. A hole fifteen centimeters deep and two centimeters across was made in an anvil weighing 200 kilograms. A wall 2.50 meters high and half a meter thick was blown down by 3¼ kilograms in zinc cartridges. A boat laden with hydraulic cement sank in the Rhine, near Cologne, and impeded navigation. One hundred and thirty kilograms of "stonebreaker" were simply placed on it and exploded by a battery on shore. The boat and its cargo were reduced into fragments, which the current carried away.

Dynamite has been used in agricultural operations. Signor Rossi Fedegrotti found that he saved 30 per cent. in money and 50 per cent. in time. One piece of ground required, in order to dig to the depth of 1.30 meter, the work of eight men for seven days and an expense of 62½ lire. The other piece of equal size was turned up to the same depth by mines three meters apart, containing each seventy grams of dynamite, No. 1. The work required the labor of the eight men for only three days and a half, and cost 43½ lire.—*New York Sun.*

ARTESIAN WELLS AS FACTORS IN THE WATER SUPPLY QUESTION.

From a late issue of the Cincinnati *Commercial* we take the following facts in regard to artesian wells in that city. After briefly enumerating those wells which yield water from moderate depths the article gives a history of the most important.

THE ARTESIAN WELLS AT THE GAS-WORKS.

John F. Pfeffer, the contractor, commenced operations July 24, 1880, by sinking a six-inch wrought-iron tube, through clay, sand and gravel to a depth of 123 ft., at which point he struck a stratum of blue limestone, and commenced drilling with a 4½-in. drill, passing through blue limestone 40 ft., gray limestone 50 ft., sandstone 5 ft., limestone 380 ft., white limestone 240 ft., sandstone 65 ft., very hard limestone 15 ft., red sandstone 62 ft., white sandstone 85 ft., coarse sand and limestone 15 ft., sandstone 140 ft., and then through 35 ft. of very hard, flinty stone—resembling granite—finally attaining a depth of 1,265 ft. on Nov. 5. On Nov. 8 a test showed a pressure of 30 gallons per square inch and a flow of 90 gallons per minute.

The same contractor commenced, on Nov. 16, 1880, to sink well No. 2, at a point 77 ft. west of No. 1, passing through the same character of formation. The water commenced flowing over the top of the well at 1,320 ft., and the desired pressure and volume was obtained at a depth of 1,360 ft. Operations were renewed on No. 1 and an additional depth of 100 ft. was attained, when the combined supply was deemed sufficient for all desired purposes. After the proper pipe connections had been made a thorough test was had, showing a pressure of 38 lbs. per square inch, or sufficient to raise a column of water to a height of 87 ft. above the level of Front street and allowing it to flow into tanks 60 ft. above the cellar level, at the rate of 8,000 gallons per hour.

The following analysis gives the character of the water:

	Grains.
Calcium carbonate	17.3421
Magnesium carbonate	8.1441
Sodium chloride	519.6034
Potassium chloride	3.2729
Magnesium chloride	18 1431
Calcium chloride	22.2813
Calcium sulphate	27.2726
Magnesium iodide	.1982
Magnesium bromide	.2631
Iron oxide	.37:1
Silica	.4926
Loss in analysis	.8132
Total	618.17e9

In one gallon of the water, and holds also in solution the following gases:

	Cubic in
Sulphuretted hydrogen gas	7.75
Carbonic acid gas	10.35

I would also report that the character of the water is very similar to that of the well-known Blue Lick Springs, of Kentucky; also that of the Moerlein well in this city. It has the same medicinal value and contains nearly the same amount of mineral matter as they do. Respectfully yours, etc.,

E. S. WAYNE, Chemist.

The entire cost of the two wells, connecting pipe, etc., was $,293.67.

Six per cent. on this sum would be $496.98, whereas the same volume of water, if charged for at city rates, would cost $8,760 per year—his operations resulting in an approximate saving to the gas company of $8,000 per year.

THE MOERLEIN WELL.

The Moerlein well was the first mineral or flowing well bored hereabouts, and was sunk about three years ago. It has a depth of 2,408 feet below the surface, and, as said above, gives an ample supply for both drinking and brewery purposes; and it is a curious thing that its waters are sold at many of the beer saloons at five cents a glass.

The following is a comparative analysis of the waters with those of the Hot Springs:

Constituents.	Sulpho-Saline Water, by Dr. Wayne.	Hot Springs, Ark., Water by Dr. Wardlaw.
Carbonate of lime	19 3421	3.6008
Carbonate of magnesia	9.1271	.....
Chloride of sodium	534.7718	.1339
Chloride of potassium	3.9472	.....
Chloride of magnesium	17.2835	.1870
Chloride of calcium	22.1903	.....
Sulphate of lime	29.2031	.7541
Sulphate of potash	2.3016	.3008
Sulphate of soda	.....	.0890
Iodide of magnesium	0.2970	.....
Bromide of magnesium	0.3945	.....
Oxide of iron	0.4297	.0968
Phosphate of soda	1.3401	.....
Silica	0.7963	1.9831
Loss in analysis	0.7642	.....
Alumina	.....	.4291
Organic matter	.....	.7084
Total grains	842.1634	8.3500

OTHER WELLS.

So pleased are the gas company with their wells that General Hickenlooper is having another bored at Sportsmen's Hall, and of the pumping there are reports from all sides of the intention of citizens to "run their own water-works," so to speak.

The mania has spread to the Kentucky suburbs of the city, and Mr. Edward A. Boluss, of Covington, Ky., has just completed an artesian well at the St. Bernard Starch-works of 16 in. diameter and 115 ft. depth, which yielded yesterday with a small pump, at the depth of 28 ft., between 5,000 and 6,000 barrels of water. It is estimated that this well, with a large pump and at a lower depth, will give 15,000 to 20,000 barrels per day. The water is soft and pure, and well adapted for the works.

SUGGESTIONS.

The success of the cheaper wells, if their water prove drinkable, will cause many citizens, even for their private houses, to seek their water supply on the artesian plan, and be free at once from the perplexing question as to the purity of the river supply and the annoying visits of the water-rate collector. The financial part of the showing made by the gas company will cause manufacturers using a large amount of water to go and do likewise. It is even worthy the attention of the authorities as to whether or not a large part of the public supply could not be obtained cheaper in this way than through expensive Markley farm projects. The gas company's experience shows that permanent fire-plugs could be established in threatened localities capable of throwing a very high stream, and of supplying engines liberally. The pressure after the flowing power is struck seems to be determined by the depth, just as the expense of the wells is regulated by the number of feet bored. It is a noteworthy fact that after water is reached at between 150 and 300 feet, for pumping purposes, there is no medium between that and a free flow, the pressure not being felt until a certain stratum of flinty rock is perforated at a depth somewhere between 1,500 and 1,600 feet.

The Atchison, Topeka & Santa Fe Railroad Company has purchased no less than 75 locomotives this year from the Brooks, Pittsburg, Baldwin, Hinckley, Taunton and Rhode Island locomotive works, and has under contract for 1882 100 more, distributed as follows: Baldwin works, 40; Hinckley, 35; Manchester, 15; and Taunton 10. The same company has received this year 4,000 freight-cars, 50 coaches, and 22 baggage and mail cars.

THE ELECTRIC LIGHT IN A SCOTCH COLLIERY.

On Tuesday afternoon, Aug. 9, Earnock Colliery, near Hamilton, belonging to Mr. John Watson, of Earnock, was the scene of an interesting ceremonial which may well be said to mark a new era in mining annals. In proceeding to win the rich mineral wealth of his estate Mr. Watson determined that, in respect of fittings, machinery and general appointments, it should be a model, and he has been highly successful in giving practical effect to his aims. Among other things he early resolved to, if at all practicable, substitute the electric light for the ordinary mode of illuminating the workings, and after investigating the various systems he decided on giving that of Mr. Swan a trial. Accordingly, since April last, Messrs. D. & E. Graham, electrical engineers, Glasgow, have been engaged fitting up the Swan incandescent lamp, with modifications, to adapt it for safe use in the mine, and on Tuesday the inauguration of the new light took place in presence of a large company of leading gentlemen from Glasgow, Hamilton and the West. Arrived at the colliery about half past one o'clock, the visitors were received by Mr. Watson, and after a brief space spent in inspecting the three magnificent winding and fan engines, the Guibal fan, and framework for screening the coal, they were conducted by Mr. James Gilchrist, manager, down into the workings in the ell seam at a depth of 118 fathoms. Here at the pit bottom, in the roads and at the face, twenty-one Swan lamps were burning, giving forth a brilliant, steady flame, the luminosity of which, while sufficient to supply the desired light, had none of the disagreeable intensity associated with most systems of electric lighting. Besides the pear-shaped Swan lamp, in which the glowing or incandescence is carried on in vacuo, there is an outer lantern, the invention of Mr. David Graham, consisting of a strong glass globe, air-tight, protected with steel guards. Each lamp was also connected with two different forms of Graham's patent safety air-tight contacts and switches for cutting off and letting on the current, the effect of which, it is believed, would be to render the lamps quite safe, even in the presence of explosive gas. At first the intention was to employ the fan engine to drive the dynamo-electric machine or generator, but this was departed from, and an engine of 12-horse power was erected in the workshops on the surface for the purpose. From the generator the electric cables, two in number, are conducted along the roof of the workshops over ordinary telegraph poles to the pit-head at No. 2 shaft, and thence down into the workings. From the ridge of the workshops to the pit-head, a distance of several hundred yards, the cables consist of ordinary copper wire, ⅜-in. diameter: inside the workshop and below ground, to allow of their safe handling, they are composed of insulated wires, while on the way down the shaft they are inclosed in a galvanized tube. Near the bottom of the shaft, branches are taken off to supply light to the principal roadways and to the haulage engine-room, the main cables being carried into one of the sections of the mine, a distance of half-a-mile. After a careful inspection of the lamps at the pit bottom, the party were photographed in three groups, with the aid of the electric light, by Mr. Annan, of Glasgow, who may well be credited with the distinction of being the first to exercise his skill in the bowels of the earth. They were led to the haulage engine-room and into the workings, where they witnessed the effects of the light. At the latter point, while, of course, the visitors were at a safe distance, a shot was fired, bringing down a large mass of coal. Having spent fully an hour below ground, the party returned to the surface, where carriages were in waiting to convey them to Earnock Mansion House, where luncheon was served.—*Colliery Guardian.*

SURVEYING THE COAST.

A writer in the New York *Herald*, writing of the United States Coast Survey, says:

And now we come to the science of hydrography or a survey of the water. To prepare a hydrographic sheet for work, a projection of the lines of latitude and longtitude has to be made identical with those made for the topographer. Points of triangulation are plotted, as for him; but, besides these, the short line from his topographical map of the region is accurately transferred to the hydrographic sheet, so that the hydrographer may be able to lay out his work and plot his lines when run. In hydrography

the first process is the selection of a site for "a tide gauge" and the erection of the gauge. The simplest form (which is commonly used in harbor surveying) is a graduated staff divided into feet and tenths; but there are now elaborate forms depending for the necessity of their use upon local circumstances or the accuracy of results required. Observations of the high and low waters of every day are begun at once (as soon as the staff is up) so as to obtain as many as possible during the time occupied by the survey, and hence an accurate mean. Next in order come "signal building," for the measurement of horizontal angles in hydrography is done'ge erally with the unaided eye, and signals must be large, of a striking or easily-recognized form, and whitewashed, so as to catch the eye quickly. Sometimes flags of different colors are used, according to the background against which they show, but these details are to be determined by the judgment and experience of the hydrographer. With the tidal observations well under way, and the necessary signals prepared, the boats and the vessel are made ready. Leadlines are carefully marked and examined (generally they are marked in feet and fathoms), sextants or theodolites adjusted, and the hydrographer starts his boats fully equipped for sounding.

A full crew is composed of six oarsmen, two leadsmen, one coxswain (to steer), two officers as observers, and one as recorder. In practice, when all are experienced, a much smaller force of officers has been successfully employed. Starting from some point, whose position is determined by two horizontal angles between three fixed points, the boat is turned upon her course, and a line of soundings is taken across the bay or harbor to the opposite side. Soundings are taken as rapidly as possible, the boat or vessel keeping a uniform rate of speed; the recorder notes each one, and also the time, at regular intervals of one minute, unless the bottom is very uneven or the depths great, when time is noted at every sounding. At intervals during the progress of the line angles are measured between three known points on shore and duly recorded, and thus the boat's position is known throughout the whole length of each line. On reaching the opposite shore (or the end of the line, if it be run off shore) angles are again carefully taken, and the boat put upon a new line. Lines are usually run parallel to each other, at right angles to the shore; and are crossed by others right angles to the first set; but all ledges and shoals are separately developed—the lines being run in every direction and as closely as they can be plotted until the whole shoal area has been fully covered. While the boats are thus engaged the rise and fall of the tides are noted at the gauges every five minutes, but when there is no boat sounding only high and low waters are taken. The lines run are plotted on the working sheet by the same means through which the angles were taken in the boat—that is, the two sextant angles at each position are laid off right and left from a fixed central arm of a three-armed protracting circle; and the protractor is then moved about on the paper until the three arms are brought on with the positions of the proper signals marked on the sheet. The center point of the instrument is then the position of the boat when the angles were taken. All positions having been plotted, lines in pencil are drawn between them on each sounding line; and in the course of time the sheet is crossed and recrossed by a net-work of lines, on which the soundings are to be plotted.

A mean of low waters having been obtained by observations of every low water during one lunar month at least, the surroundings as recorded are reduced to this mean, and the draughtsman is then ready to put on the sheet the reduced soundings, or so many of them as he shall select, with a view of presenting a perfect figure of the bottom and the shape and extent of the shoals. Over a level bottom soundings are selected between the angles at equal intervals of space, without regard to time. Where the bottom is broken time alone is taken into account. It is obvious that a leadsman will take fewer soundings in deep water than in shallows, and that the boat, preserving the uniform rate of speed, will pass over more ground in the time between two deep soundings than between two of less depth. In soundings of ten fathoms and over (especially in a strong current) angles should, if possible, be taken at every sounding. When the soundings have been plotted, the curves of 6, 12 and 18 feet are drawn upon the sheet in colors, so as to represent the slopes and irregularities of the bottom as the contour lines of the topographer show the undulations of the land. The chart is now ready for the central office, at Washington, where field work is carefully verified and the survey reduced to the scale of publication. In practice, few officers plot the surroundings on the original sheets, leaving that work to the skilled draughtsmen in the central office—but it is a good plan to put upon the lines in pencil as much work as possible, so as to check it, to discover errors, and get an intelligent comprehension of the figures at the bottom as he goes along.

The survey is now complete—triangulation, astronomy, topography and hydrography—and it remains to prepare these for publication so as to form a complete and harmonious whole, which, when published, forms the finished chart so invaluable to mariners. The original sheets are sent to the central office, and there pass through different processes. If a preliminary edition of a certain coast or harbor is desired the original surveys are combined in one careful and elaborate drawing (generally on tracing vellum), which forms a complete chart, and is transferred to stone in a reduced form by the photo-lithograph process. An edition, according to the needs of the public, is printed from the stone, and so rapid is the process that a complete and accurate chart for mariners can be put upon the market a few weeks after the reception of the original survey at the central office. The objection to this method of publication is that it is not lasting. As soon as the required edition has been published the stone is cleaned, and should a new lot be wanted, the photo-lithographic work must be done over again. Besides, these imprints, though quite accurate, have not the finish upon which a great nation would wish to rest its reputation for superior cosmography.

The permanent charts are, therefore, prepared in a different fashion. Although formerly the original topographical sheets were reduced to the publication scale by laborious hand reduction, photography now steps in and produces in a few moments reduced copies of the original surveys on any scale desired. The photographic reductions, being combined or joined together on a sheet of the required size for the chart to be engraved, are sent, after some manipulation in the draughting rooms, to the engraver. Upon a plate of rolled copper, which has been previously coated with a thin film of wax, the engraver transfers the lines of the drawing by a delicate tracing on fish glue. He then marks the lines on the plate with "a point," finally cutting them with "a graver," comparing with the original as he proceeds, and subjecting it from time to time to the test of a "proof" through the printing press. The topographical engraving having been completed, the hydrographic work must be engraved. For this the engraver receives a separate drawing, which, with the exception of the shore line, is reduced by hand. The necessity of hand reduction of hydrography becomes obvious when we consider that whereas topographical features are easily reduced by photography, and will present, when so reduced, clear and distinct outlines, on the other hand so many soundings are plotted on the hydrographic sheets that if reduced by photography to a small scale they would produce a confused and indistinguishable mass, besides requiring the engraving of more figures than would be necessary. Therefore a skilled draughtsman marks upon a sheet of drawing paper, upon which the shore line has been previously traced, such soundings selected from the original sheet as will give a correct figure of the bottom. He also marks all shoals and ledges, names of points, streams—in short, what is called the "general lettering" of the chart. This goes to the engraver, who cuts from a correct tracing these soundings and lettering on the same plate which already has the topographical features. Then follow the finishing touches—the title, compasses, notes of information, border, etc.; and the plate having been carefully verified as to every sounding, line and letter, is finally declared completed.

At the present writing the Coast Survey employs 173 persons, of whom 46 are assistants, 9 subassistants, and 12 aids, the balance being made up of clerks, engravers, draughtsmen and artisans. As nearly as can be ascertained, the condition of the work at the commencement of the present year was as follows: The coast triangulation is complete on the Atlantic and nearly so on the Gulf coast. On the Pacific it covers two-thirds of the coast. Both systems have been connected with the interior triangulation (already in operation in 25 States), and the latter will soon extend over the whole country. The topography is complete on the Atlantic coast, except a portion of the seacoast of Maine, and a small part of Florida. On the Gulf coast part of Florida, and some of Louisiana and Texas remains to be done; and of the Pacific coast about one-third is unfinished. The hydrography keeps pace with the topography; and there are therefore but few harbors of which handsome and accurate charts cannot be furnished on demand. In a word, the time is close at hand when the Coast Survey will be able proudly to point to a continuous series of admirable charts of both land and sea from Maine to Mexico and from Lower California to Vancouver's Island. By cables, our longitudes are connected with the central meridian at Greenwich; by telegraph, chains of accurate determinations of longtitudes bind the Atlantic to the Pacific, and extend up and down the coast of both great oceans; and with such results as these, and with the glorious prospect of uniting in the near future both the oceans and all of the States in a network of triangles which shall form a firm foundation for local topographical delineations, the Coast and Geodetic Survey may well be proud of its labors and may justly claim from the country, whose resources it is developing and whose name it has ennobled over the civilized globe, just recognition and liberal support.

LEVEE BUILDING ON THE MISSISSIPPI.

Mr. William L. Murfee, Sr., in *Scribner's Magazine*, thus describes the modern method of building a levee: The space which it is to occupy is first carefully cleaned off; trees, roots, stumps, logs, weeds, even grass and leaves are removed. Then in the middle of the space, extending longitudinally the whole length of the proposed work, is dug a ditch three feet wide and three feet deep, which is to be straightway filled up again. This is called a mock ditch, or as some people say, a "muck ditch," but why "muck" is one of the things that has not yet been found out. The object of this has been twofold—to close all root holes and to mortise the superstructure into the natural earth, thus preventing any sliding under the pressure of the water. As the levee is built of loose earth, its mass coalesces with the loose earth with which the mock ditch was filled, and when the levee has been completed and settled it forms, with the contents of the mock ditch, a homogeneous mass anchored three feet along the line in the solid ground. The next process is to build the levee. The material is to be taken only from the outside, or side next the river, and should not be cut nearer than 20 ft. from the base of the levee; the earth is carried in wheelbarrows upon run plank. The dimensions of levees have varied from time to time, according to the amount of funds available for their construction. In any case the top of the levee should be 3 ft. perpendicular above high water mark; the base line should be 5, 6, or 7 ft., according to the ratio in force, or every foot of perpendicular height; the top should be level, and as broad as the levee is high. Thus, where high water mark is 4 ft. above the level of the natural bank, the perpendicular height of the levee should be 7 ft., the breadth at the top should be 7 ft., and its thickness at the bottom 35 ft., 42 ft., or 49 ft., as the ratio of 5 to 1, 6 to 1 or 7 to 1 might be in force. Taking for illustration a 7-foot levee constructed upon this ratio, it will be observed that with the water standing 4 ft. deep there will be on a horizontal line 25 ft. of solid earth between the surface of the water outside and the air inside, and 49 ft. between the bottom of the water without and the air at the natural surface of the earth within. The last but indispensable step in the process of levee building is the "seep water ditch," which is dug some 30 or 40 ft. from the inner margin of the levee and parallel with it. The function of this ditch is to receive and conduct away the seep water, or transpiration water, which oozes in considerable quantities through even the most compact of levees. If permitted to remain it would render the ground about the inner base of the levee intolerably muddy, and would operate as a great disadvantage in case of emergency. The deep water ditch must be connected with plantation ditches or otherwise put in communication with the swamp in the rear, so that the water can be carried away. Finally, as a finishing touch to the new levee, it should be planted with Bermuda grass. If tufts of this grass be set two or three feet apart all over the surface of the levee, it will in a year or two cover it completely with a very dense sod, and by its interlacing roots add materially to its water-resisting capacity. When water stands for a long time against a levee, the current and the waves seriously abrade its surface, butting in sometimes so deep that an inopportune wind-storm would assuredly break it. A heavy coat of Bermuda sod is a very efficient preventive of this kind of disaster. I have seen at the end of a long period of high water, a piece of levee deeply indented all along the line, and in some places cut more than half through, while adjoining it was a strip of Bermuda-covered levee, subjet to the

same exposure to wind, wave and current, which had not apparently lost a pound of earth or a tuft of grass.

IRON SLEEPERS.

The experimental adoption of iron sleepers on the London & Northwestern Railway, as described by Mr. Webb, at the recent meeting of the Iron and Steel Institute, is likely to draw fresh attention to this important question. In the early days of iron sleepers it was alleged that they would speedily be destroyed by rust; and probably in England, at least, this fear is by no means extinct, and may yet prove a bar to their adoption. In Germany, where iron sleepers have made most progress, this fear has long subsided; but, nevertheless, actual statistics on the subject are worth recording. Some such are furnished by the experience of the Lubeck & Hamburg Railroad, as lately recorded in the *Railway Organ*. This relates to iron sleepers laid on the two middle tracks, besides two sidings at a lower level. This is worth noting, because the moisture is, of course, longer in getting away from a wide embankment of this kind, and consequently there is more danger of rusting. The first lot of sleepers was laid down in May, 1878, and was partly coated with tar, partly left quite unprotected. The second lot was laid down in October, 1879, and had one coat of paint. In 1880, a third lot was laid, and these, instead of being straight throughout, were bent downward at the ends in order to hinder the working up of the ballast at the ends, which was found to be an objection with the old form. This has proved successful, and in consequence a large number of the old sleepers have been taken up and replaced by the new type, which has given the opportunity of observing their condition as to rust, both inside and outside. The general results are as follows:

In the sleepers laid without any protection two and a half years before, there were some traces on the outside, but near the middle only, and slighter traces all over the inside. In the tarred or painted sleepers (of which the former had been laid two and a half years, and the latter ten months) the coating was rubbed off in some places, just at the connection between the sleeper and the rail; but no traces of rust were visible, and elsewhere the coating was quite uninjured. In instances the ballast was found adhering to the sleeper just below the rails, and for about a foot on each side, especially with the tarred sleepers. On removing this ballast the coating was found to be uninjured. None of the bearing surfaces, whether between the sleeper and the rail or between the sleeper and fastenings, showed any perceptible wear. The security of the fastenings (which were chip-plates bolted down upon the rail foot) against all shifting sideways was proved by the fact that where there had been any clearance between the chip-plate and the edge of the hole in the sleeper it was found to be filled up with clay from the ballast. No alteration had taken place in the longitudinal section of the sleepers or in the gauge, although during the passage of a train the bending of the sleepers had been observed to open the gauge by a distance of 1-16th inch to ⅛-inch. The coating of the sleeper, inclusive of the removal of the scale, costs about eight cents with paint, four cents with tar. By using tar, therefore, a sleeper may be secured against all danger of rust at an almost nominal cost.—*North American Manufacturer.*

NOTES.

DYNAMIC GENERATORS.

According to reports attributed to the officers of the Western Union Telegraph Company, where dynamic generators have been substituted for decomposition batteries for the generation of the current, the cost of charging the wires with the dynamic current is about one-half what it was under the old system. Readers of the *Times* will recall that some months ago, in a description of a system of telegraphy devised by one of our prominent electricians, in which the dynamic current was employed in place of that generated by decomposition, the reduction in the cost of charging was stated in figures closely corresponding to those developed by the experience of the Western Union Company. The statement was sharply taken up at the time by the partisans of the dynamic current in a series of communications, and some even went so far as to claim that the actual cost, volt for volt, of dynamic electricity was about one-sixtieth of that developed by decomposition. This extraordinary assertion was based upon the fact that a pound of coal contains a certain amount of power whose quantity in foot-pounds can be accurately measured and determined. The amount of power in a pound of copper or zinc is also accurately determinable; and when these two factors of the problem alone are compared, and this comparison is made the basis of an estimate of cost, the relative ratio shows an advantage in favor of coal of between 45 and 60 to 1. The reasoning looked very plausible on paper, but, unfortunately, there were certain factors which the partisans of dynamo-electricity did not take into account. In the use of the dynamic generator the number of foot-pounds of energy contained in a pound of coal is one thing, and the actual percentage of that energy which appears in the circuit as electricity is quite another. In the first place, the imperfect combustion of the coal in the furnace must be regarded, and, although it may seem strange to the popular reader, in view of the great advances that science has made of late years, it is none the less a fact that not far from four-fifths of all the heat-forming energy contained in a pound of coal is wasted in the furnace through imperfect combustion; so that in operating a steam engine only about one-fifth of the actual energy of the fuel is converted into steam. This fact is so well verified that able engineers have already turned their attention to the construction of furnaces to produce perfect combustion, and the next step in the economical generation of power will no doubt take the direction of better constructed furnaces. In the second place, only about 40 per centum of the energy transferred from the engine to the generator is actually converted into available current, and so three-fifths of the steam power is lost before the transformation into current is completed. If, for example, the amount of energy contained in a pound of coal be placed at 100, 80 of this 100 will be lost by imperfect combustion, and 12 out of the remaining 20 will be sacrificed in the development of heat in the generator. The result is that only 8 per centum of the actual energy contained in a pound of coal is transformed into current in the use of the dynamic generator, while the larger proportion of the energy contained in the copper or zinc is converted, and this is the reason why the theoretical and the practical relations of the two methods are so at variance with each other, and why those who based their computations upon a mere comparison of foot-pounds of energy were so wide of the mark in their statements.—*N. Y. Times.*

EXPERIENCE WITH CREOSOTED TIMBER.

Capt. J. W. Craig, the Road-Master of the Charleston & Savannah Railway, who was sent out by Superintendent Gadsden to make a survey of the Mobile & New Orleans Railroad, and ascertain by personal inspection the value of using creosoted timber in the construction of railroads, wharves, etc., as a protection against the terrible teredo, has returned to the city and made his report. He found that the creosoting process is a perfect protection against the ravages of the teredo, and at West Pascagoula saw piles that were put in six years ago in perfect preservation. He also found that the life of timber subjected to this process, but not exposed to the worm, was increased, and at West Pascagoula saw two-inch plank used in building abutments perfectly preserved. Whether exposed to the weather or buried under ground, it was alike well preserved and sound in every particular. On the Mobile & New Orleans road it is used in building frames, in planking platforms, in the construction of trestles and bridges, with the same favorable result, and from one end of the road to the other he could not find an inch of decaying or rotten timber. He also found that the softer woods are better suited to the process, as they absorb the oil more rapidly. The woods used are the loblolly pine, gum, oak, ash, maple and beech. The soft yellow pine, which so largely abounds in this State, is especially well suited to the creosoting process, as the sap vessels in it are large. In treating the timber, it is placed in large iron holders and completely relieved, by evaporation, of all the moisture it contains. After this has been done coal tar oil is forced into the sap vessels of the timber by a pressure of from 120 to 130 pounds to the square inch, the pressure being completed and the timber ready for use in about 36 hours after it is placed in the iron tanks or holders. Captain Craig's investigation was made with a view to using the creosoted timber in a number of places along the line of the Charleston & Savannah road, where the ravages of the worm baffle the skill of the architects and greatly increase the cost of maintaining the line. So well convinced is Major Gadsden of the creosoting process that he is now negotiating for the purchase of a lot of piles for use on his road. The piles are worth from $10 to $12 each, delivered in the cars at the place of manufacture, but even at such figures it would be economy to buy them.—*Savannah (Ga.) News.*

MOUNTAIN TUNNELING.

Mountain tunneling is a far less expensive and laborious business now than it was several years ago, as statistics for work at present going on in the Alps, and for work already accomplished there strikingly show. While Mont Cenis was bored at the rate of 1,112 meters a year, and the St. Gothard at the rate of 1,670, the Arlberg is expected to be pierced at the rate of about 2,160. The cost per running meter of the Mont Cenis was $2,000, and on the St. Gothard it has been $1,250; but the outlay on the Arlberg will not exceed $750. The chief difficulty in Alpine work does not lie in quarrying out the passageway, but in getting rid of the dirt and rock after it has been taken down. After every blast this material must be removed before boring work can go forward again. Five years will be required to finish the Arlberg work, and two and a half will be consumed in actual boring and excavating, and two and a half in carrying away the rubbish. Since the work was begun, in June, 1880, the gallery on the east side has been driven forward 1,010 meters, and the one on the west side 710 meters.

FOREIGN INTELLIGENCE.

Work on the St. Gothard Tunnel is progressing well. Some hope that the whole gigantic scheme will be completed by the 1st of July, 1882.

THE NEW TAY BRIDGE.—Examinations of the foundation at the old bridge convinced Mr. Barlow that it was requisite to make more allowance than had been before done for the scour of the river, and that the safest and best plan would be to put in piers for a double-way bridge entirely independent of the old piers. The erection of the bridge on this slightly altered site will require the construction of two or three short pieces of railway, and from the shore to the junction solid stone piers will be employed. The total length of the new bridge is a little over ten thousand feet, or about two miles. It is similar to the old bridge with regard to the number of large openings. Each pier is opposite a pier of the bridge. The calculations are made for double the wind pressure that will ever be brought to bear on the holding-down bolts. In reply to a question very pertinently put by Viscount Folkstone, Mr. Barlow said that the wind pressure was calculated at twenty pounds per square foot, and that, in point of fact, the design allowed fifty-six pounds pressure of wind and train. This is close upon the allowance made by the American engineers, and is, in our opinion, ample, if it be regarded as a probable strain that is not likely to come on the bridge—the breaking strength being at least double. It would not, in our opinion, be safe if the breaking tension is put at less than one hundred and twenty pounds per square surface on which the wind can lay hold, so as to exert a leverage against that resistance, and, no doubt, this is what is meant by the evidence. The piers are to be solidly connected with girders. The parapet will be of wrought iron, as a precaution in case of any vehicle leaving the rails. There are also strong balks of timber placed as fenders outside the rails. It is intended to use some portions of the old girders, after proper testing, in the new structure.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

Fairplay, Col., is to have water-works at a cost of $10,000.

Selma, Ala., has no less than fifty-five overflowing artesian wells.

Gentlemen of Washington, Pa., are attempting to form a water-works company.

Greencastle, Ind., will vote on the 20th inst. on the question of constructing water works.

A supply of water is to be brought into Gardner, Mass., from Crystal Lake, a mile and a half distant, by the Wiley Construction company.

Water is supplied in Boston to 33,338 dwelling-houses, containing 51,212 families, 1,554 model houses, 5,882 stores and shops, 884 bars and saloons, 1,994 stables and 3,969 fire hydrants.

The city council of Cairo, Ill., on the the 23th ult. accepted a proposition of T. Daniels, of Clarksville, Tenn., to construct a system of water-works in that city, the works to commence within sixty days.

The water supply of the town of Stockbridge, Mass., is abundant now for ordinary purposes, a bad break in the mains having been repaired the other day. Water for street-sprinkling is pumped from the river by horse-power.

A Pittsburgh, Pa., dispatch of the 29th says: "The pumping main leading to Herron hill reservoir, which was broken at the Center avenue bridge, about a week ago, thereby cutting off the supply to the basin, has been repaired, and the pumps were set in motion this morning."

YANKTON, Dak., Aug. 29.—At 460 feet depth the Yankton artesian well borers struck flowing water in lime formation, which flows 150 gallons per minute through a six-inch pipe. In the same pipe water was carried fifty feet above the surface of the ground. This is the first well in Dakota, and as it is a cheap success, another will probably be bored here immediately. The well company will lay pipes to supply the city with artesian water.

PERTH AMBOY, N. J., Aug. 31.—The company organized here recently for the purpose of supplying the city with the needed water-works is pushing ahead the work on the reservoir as fast as possible. A fine brick building is being erected near the new reservoir, which will contain the immense pumps and the powerful engine of the company. The daily capacity of the works will be over 3,000,000 gallons. The force will be so great that five streams of water can be thrown at once over the tallest building in the city, thus giving ample security from fire without the use of fire-engines.

The city of St. Joseph, Mo., is having trouble with its water supply. One of the reservoir embankments gave way and the largest of the two engines was broken from some cause not made known to the public. The water supply was consequently cut off for a week, and the *News* of that city of the 19th instant says: "Everybody is indignant, and claim that they are being treated in a most outrageous and shameful manner. There is much real suffering in regard to this water supply and many persons are compelled to pay for having water hauled, and those who cannot afford that, have to carry it."

ELECTRICITY.

It is said that the Baltimore & Ohio Railroad Company are about to establish their own independent telegraph system. They have already 1,200 miles of wire in operation.

The Telegraph Combination, known as the Great Northwestern of Canada, controls 25,000 miles of wire, 17,000 miles of poles, and has 2,500 offices. The capital invested is over three million dollars.

STREETS, DRAINAGE, ETC.

The streets at Atlantic City are now sprinkled with sea water.

BRIDGES.

The Richmond, Allegheny & Ohio Central Railroad engineers have completed the plans for the bridge across the Ohio River at Pomeroy. The center span will be 400 feet, and 90 feet above low water. The bridge will in no way interfere with river interests.

In order to lay the foundation of the abutments of the Massachusetts Central Railroad bridge across Fort River it has been found necessary that Holley's mill-pond should be drawn off, and the company have hired the mill at $5 a day as long as the water is kept down, or until the pits for the abutments are dug out and the stone-work is above the water level.

The selectmen of Stockbridge, Mass., have contracted for the building of a new iron bridge near Charles E. Butler's, for which the town appropriated $2,500, Mr. Butler paying the balance. J. H. Burghardt & Co. build the abutments and George S. Morison, of New York, the iron work. It is to be a single span, 87 ft. long and 18 feet wide, and will be one of the finest in the town.

LONG BRANCH, Aug. 31.—The Board of Chosen Freeholders of Monmouth County held a special meeting to-day at the West End Hotel to consider the question of a new bridge over the inlet at Ocean avenue, between the West End and Elberon. After considerable discussion, it was decided to replace the present worn-out wooden structure with a substantial iron bridge, 250 ft. in length and the full width of the avenue. It will have a walk for pedestrians on each side of the roadway, and will be commenced as soon as possible.

RAILROADS.

The Buffalo, New York & Philadelphia syndicate has just ordered 500 twenty-ton freight cars, at a cost of from a quarter to a half million.

The Cedar Hollow Railroad Company, in case the Pennsylvania builds its Phœnixville branch, will apply for a charter to extend for the sake of connections with it.

The Baltimore and Ohio Railroad Company has fully decided to build a line of road from Pittsburgh to Chicago Junction, in order to materially shorten the route between Baltimore and Chicago.

Boston papers speak of it as settled that the Chicago, Burlington & Quincy Railroad Company will complete its line to Denver, where it will make the long-desired connection with the Denver & Rio Grande road.

Large sales of steel rails are reported for 1882 delivery. Prices continue to be quoted at $55 to $60 per ton at mill, according to point of delivery. English steel rails are active, and quoted at $50 to $62, according to point of delivery.

The construction of the Arkansas Valley route is to be pushed through on the Texarkana division. A contract has just been awarded for building 20 miles of the road from Monticello to within four miles of Warren, in Bradley County.

The contract for grading the first fifteen miles of the Kansas City, Springfield & Memphis has been let. This week it is expected that fifty miles more will be let, and so on as fast as the engineers can prepare profiles and specifications.

The survey of the Pennsylvania & Martin's Creek road has been completed, and its directors have been conferring with the officials of the Belvidere, Delaware branch of the Pennsylvania for the purpose of locating the connections with the Pennsylvania road. The work of construction will commence to-day.

The managers of the New York, Chicago & St. Louis Railway expect to have 125 miles of road completed and in operation between Fort Wayne and Bellevue by the middle of October. In addition to this there will be many shorter stretches of road completed in other portions of the line.

The Rochester & Pittsburgh Railroad is being pushed with a great deal of energy. The contractors have now 1,800 men at work, and have already ordered 11,000 tons of steel rails from Troy and the Cambria mills. The road is expected to be completed in the autumn of 1882, with a branch to Buffalo.

The New York, West Shore & Buffalo has contracted for 40 new locomotives. The company is now rapidly engaged in converting the Northern New Jersey Railroad into a double track line and correcting its grades. The road runs from Nyack to Jersey City on the west shore of the Hudson.

A new locomotive, to be run with the Holland hydrogen fuel process, is being constructed for the company at Paterson. The machine weighs 40,000 pounds, and its inventor promises to draw a full train, at usual speed, from Jersey City to Philadelphia, at a cost of one dollar for fuel. The locomotive is nearly completed, and will be tried in a few days.

Telegrams from Portland, Oregon, announce that the engineering parties of the Oregon Pacific Railroad have nearly completed their work, one party having arrived at the summit and another at a point near Corvallis. Contracts have been made for the prompt delivery of large consignments of rolling stock and equipments for the projected road.

The construction of the Canadian Pacific Railway is being pushed forward vigorously; the company expect to have 400 miles of new road completed before next winter. A press dispatch states that orders have already been given for 40 locomotives, 17 baggage, 32 passenger and 1,550 freight cars; also for some 30 cabooses, for use on the new road.

President Horace Porter, of the New York, West Shore & Buffalo, says two hundred miles of it are under contract between New York and Buffalo, and that that part of the line will be done in eighteen months. The highest grade will be twenty feet to the mile going east, and not more than thirty going west. The company owns one and three-quarter miles of water front at Weehawken, opposite Twenty-third street ferry, New York.

It is reported upon good authority that the Northern Pacific Railroad will be built up the Clearwater and across the Bitter Root Mountains. This statement is confirmed by the fact that the Union Pacific Company have quit letting contracts for ties, etc., for the construction of the road east of Pend d'Orielle. Major Truax is now on a surveying expedition up the Clearwater. If this plan is carried out the cut across will save several hundred miles.

The following testimonial to the Wauchope Road Grader we think is worthy the attention of contractors who wish to make money by saving in the cost of labor:

PEMBINA, Aug. 18, 1881.

With the New Era Grader, built at Chicago, Ill., we have put up a four-foot bank, 14 feet wide, and completed in six days, of ten hours each, 8,300 yards, making an average per day of 1,383 yards. FOLEY & SHIRLEY,
Contractors on the St. Paul, Minneapolis & Manitoba Ry.

The following item appeared in our issue of Aug. 20: "From one of the levelmen on the G., St. L. & P. Ry., we received the following item: 'The line of the G., St. L. & P. Ry., which is now being located from Boulder City to Middle Park, crosses the Snowy Range at an elevation of 11,925.97 ft.'" We have received another item from levelman as follows: "Through an oversight the summit of the range was given instead of tunnel summit, which is 400 ft. lower or 11,525.97 ft."

It is understood in official circles in Wisconsin that the Chicago, St. Paul, Minneapolis & Omaha Railroad Company have sold their land grant given for building the North Wisconsin Division to a syndicate of New York capitalists. Ira W. Bird, one of the commissioners of the Farm Mortgage Land Company, states that their interest in the land grant was bought up for $160,000. The Omaha Company, according to the records in the Treasurer's office, owned on the 1st of August nearly 200,000 acres along the line of the North Wisconsin Division, valued at $1,400,000 to $2,000,000.

The Pittsburgh, Youngstown & Chicago Railroad is being rapidly constructed between Pittsburgh and Akron. The line generally follows the route of the abandoned Pennsylvania & Ohio Canal. The grading is now complete from Akron, through Cuyahoga Falls, to Kent. The engineer from Pittsburgh to Youngstown is C. A. Cooper; from Youngstown to Akron, W. C. Agnew, of Youngstown, is chief engineer, with Hosea Paul, of Cuyahoga Falls, as locating engineer. Geo. Tod, Jr., and Messrs. Hester and King are in charge of construction. At the present rate of progress the road will be completed in sixty days.

There are three railroads at present seeking suitable means of access to San Francisco. One of these is the transcontinental line, the Atlantic & Pacific. There are rumors in San Francisco to the effect that this company has bought the Santa Cruz narrow gauge, the Ocean Beach line, and large water frontage in Oakland, opposite San Francisco. Another road that is said to be seeking access to 'Frisco is the California Central. This appears, from all reports, to be a busy enterprise. Of course it is asserted that Mr. Gould is the moving spirit in the scheme. The company has a dozen parties of surveyors out between Santa Cruz, Cal., and Denver, Col., and claims to have 2,000 men grading in Utah. It is a bold and ambitious project. The line is to scale the coast range, climb to the Mariposa big trees, pass near Yosemite, and strike across Nevada, Utah and Colorado to Denver, there connecting with the Eastern system.

In the beginning of 1846, when a Broadway elevated railroad was discussed and illustrated in the *Scientific American*, it probably seemed extravagant to suggest hourly trains on a single track in Broadway. The most active imagination would scarcely have gone beyond the prediction that half-hourly trains on a double track would be required. Now what do we see? Four double lines, comprising 632 miles of elevated track, on which are ran an aggregate of over 3,000 daily trains, as shown by the inventory of property of the Manhattan Elevated Railway Company. It appears that to carry on this enormous traffic 200 locomotives and 600 cars are used, which stop at 161 stations, the force employed being about 3,000 men, whose pay exceeds $5,500 per day. As many as 274,000 persons have been carried in a single day, who paid in the neighborhood of $18,000 for the accommodation.—*Scientific American.*

RIVERS AND HARBORS.

CINCINNATI, Aug. 29.—To-night, at Pittsburgh, the Ohio River is seven inches below zero. A dry river at Pittsburgh is a foot below zero. Here at Cincinnati the river is 35 inches above extreme low water, or about four feet above a dry river bed. At Louisville, in the canal, it is about 26 inches, and on the falls it is so nearly dry that boys cross by walking on dry rock and wading through shoal water. At Evansville there is less than two feet of water. The daily departures of regular boats from Cincinnati in good water averages about 11, and the tonnage of river steamers is from 800 to 1,800. Counting the regular, the transient and the local boats, there are afloat every day in a good stage of water on the Ohio from 50 to 60 river steamers between Pittsburgh and Cairo. Not a boat of this fleet is now afloat. A few little mountain stream vessels that could sail in a saucer have come out of the tributaries of the Ohio, and are doing local traffic on the Ohio. The effect upon trade and freights is tremendous. Coal is shut up at Pittsburgh. There is no trade in salt from Pomeroy, and the Kanawaha region railway freight is too high in comparison with river rates to justify shipping in that way. At Cincinnati iron ore and coal comes by river, but they cannot get in now. Leaf tobacco growers from above and below in the great tobacco region of the nation are now paying $3 per hogshead by rail, against 45 cents by river. Our furniture manufacturers used the river for shipping their goods very largely. All the river towns feel the stress of this low water.

CANALS.

The Kaukauna (Wis.) Water Power Company has nearly completed its canal at Kaukauna. The work has cost $250,000, and is said to be the finest water power in the State.

NEW PROJECTS.

Georgia is to have a new $1,000,000 capital building. The lobby wants better accommodations.

ATLANTA, Ga., Aug. 31.—The bill to incorporate the Cincinnati and Georgia Railroad passed the Senate to-day without any amendments, thereby becoming a law. The vote was almost unanimous.

The Winnipeg & Southwestern Railway, chartered by the Manitoba Legislature to build a line southeasterly, from Winnipeg to the international boundary, has organized. All the capital has been subscribed.

SPRINGFIELD, Ill., Aug. 29.—Articles of incorporation of the Peoria & Western Railroad Company were filed to-day in the office of the Secretary of State. The company propose to construct a railroad from Peoria to Quincy. The capital stock is $3,200,000. The names and residences of the Board of Directors are as follows: John G. Fonda, Fred. W. Menke and John H. Durher, of Quincy; John A. Finlay, of Warsaw; Henry H. Osborn, of Chicago; David M. Kelly, of Green Bay, Wis.; Henry Ketchum, of New London; Stephen B. Kerrick, Fort Madison, Ia.; and Eibridge W. Merrill, Menominee, Wis.

CONTRACTING, MISCELLANEOUS, ETC.

The Union Depot at St. Paul is open for business. It cost about $250,000.

A dispatch to the *World*, dated Washington, August 24, says: Judge Lawrence, First Comptroller of the Treasury, rendered a decision to-day in which he maintains that if a contract with the government is sold by the contracting party the contract itself is annulled, and that any person or party selling such contract runs the risk of obtaining no pay. The opinion is based on the ground that the original contractor, in such event, does not perform the service, and that the purchaser of a contract violates existing law.